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METROPOLITAN WATER AND SEWERAGE BOARD

EIGHTH ANNUAL REPORT

DECEMBER 31, 1908

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METROPOLITAN WATER AND SEWERAGE BOARD.

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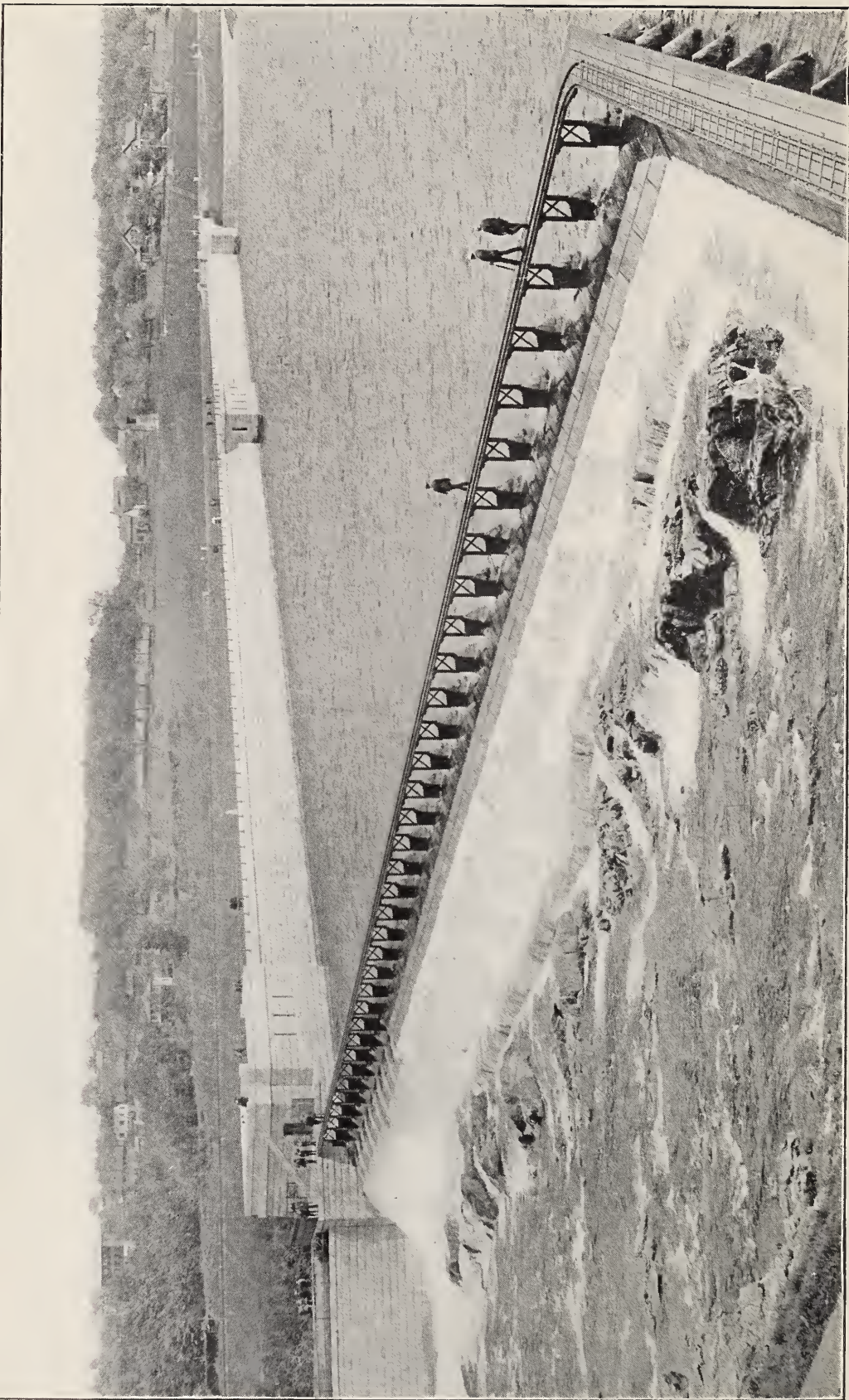
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WILLIAM N. DAVENPORT, Secretary.



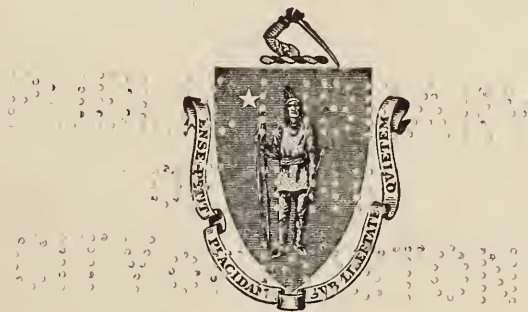
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WATER FLOWING FROM FULL RESERVOIR OVER WASTE-WEIR

EIGHTH ANNUAL REPORT
OF THE
METROPOLITAN WATER AND
SEWERAGE BOARD.

FOR THE YEAR 1908.



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Metropolitan Water and Sewerage Board
June 19, 1909

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METROPOLITAN WATER AND SEWERAGE BOARD

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METROPOLITAN WATER AND SEWERAGE BOARD.

To the Honorable the Senate and House of Representatives of the Commonwealth of Massachusetts in General Court assembled.

The Metropolitan Water and Sewerage Board established under the provisions of chapter 168 of the Acts of the year 1901, has already presented to your Honorable Body an abstract of the account of its doings, receipts, expenditures, disbursements, assets and liabilities for the fiscal year ending on November 30, 1908, and now, in accordance with the provisions of chapter 235 of the Acts of the year 1906, it presents a detailed statement of its doings for the calendar year ending on December 31, 1908, being its

EIGHTH ANNUAL REPORT

made since the consolidation of the Metropolitan Water Board and the Board of Metropolitan Sewerage Commissioners on March 20, 1901.

I. ORGANIZATION AND ADMINISTRATION.

(1) BOARD, OFFICERS AND EMPLOYÉS.

The term of office of Henry P. Walcott, M.D., expired on March 21, 1908, and he was reappointed for the three years next succeeding. The membership of the Board has consequently remained as in the preceding year: Henry H. Sprague, chairman, Henry P. Walcott, M.D., and James A. Bailey, Jr. William N. Davenport has continued as secretary and in charge of the auditing department. Alfred F. Bridgman has been the purchasing agent, and Miss Bertha M. Briggs continued as bookkeeper until October 1, 1908, when she resigned and Miss Alice G. Mason was appointed to fill the vacancy.

There are also employed in the administrative office a paymaster, an assistant in auditing, two general clerks, three stenographers and clerks, a telephone operator, a messenger, and a janitor with two assistants, one of whom acts as watchman.

George D. Bigelow has been in charge of the conveyancing work, and he has been assisted by Miss Alline E. Marcy, title examiner. They have performed such general conveyancing work and made such further investigation of real estate titles in the different counties as has been called for during the year, for the general purposes of the Board and for use in pending suits.

The consulting engineers of the Board are Joseph P. Davis, Hiram F. Mills and Frederic P. Stearns, who are called upon for services when matters arise which require such consideration.

Dexter Brackett has been Chief Engineer of Water Works, with supervision of the various departments. William E. Foss and Alfred O. Doane have continued as Division Engineers and Benjamin F. Hancox as Assistant in charge of the Drafting Department. Samuel E. Killam served as Office Assistant until October 1, when he was succeeded in that position by William E. Whittaker.

There has been a reduction in the engineering force employed in construction upon the Water Works, but a considerable addition has been required in the number employed upon the maintenance and operation of works. The average force in construction and maintenance during the year has included, in addition to the Chief Engineer, 4 department superintendents, 2 division engineers, 6 assistant engineers, and 30 others in various engineering capacities and as sanitary inspectors, clerks, stenographers and messengers, the total force numbering 42. The maximum engineering force employed at any one time during the year on both construction and maintenance was 46.

A maintenance force, in addition to those engaged in engineering capacities as above mentioned, numbering upon the average during the year 251, has been required at the pumping stations, upon reservoirs, aqueducts, pipe lines, and upon minor construction work. At the end of the year this force numbered 233.

Day laborers have in addition been employed from time to time in connection with the regular force as their services were required.

William M. Brown has continued in charge of both construction and maintenance of the Sewerage Works. He has been assisted during the year by Frank I. Capen, Seth Peterson and Frederick

D. Smith, Division Engineers, who have been in supervision of both construction and maintenance departments, by 4 assistant engineers, and 28 others employed in various engineering capacities, and by 2 clerks and stenographers.

The maximum engineering force employed at any one time during the year on construction and maintenance of Sewerage Works was 34.

The regular maintenance force required in addition for the operation of the pumping stations, the care and inspection of the sewers and for other parts of the Sewerage Works, exclusive of the engineers and day-labor forces, has upon the average numbered 145.

The whole regular force of the Sewerage Department at the end of the year numbered 173, of whom the Chief Engineer and 27 assistants and draftsmen were engaged in general upon the works, and, of the remainder, 87 were employed upon the North System and 58 upon the South System.

Day-labor forces under the supervision of the engineers and the immediate direction of foremen have been employed in the construction of the pneumatic tunnel on Section 80 of the High-level Sewer extension in West Roxbury, in extending the piping for the salt water supply to the condensers at the Alewife Brook pumping station, in making temporary repairs to the East Boston pumping station, following the Chelsea fire of April 12, and in the construction of foundations, new channels and connecting chambers in preparation for the extension of the buildings and plant at the Deer Island pumping station.

The maximum number of men employed upon contracts and upon day-labor construction on the Sewerage Works during the year was for the week ending April 5, when the number amounted to 514.

(2) OFFICES AND BUILDINGS.

The offices of the Board and of the secretary, the auditing and conveyancing departments, and the main engineering offices of both Water Works and Sewerage Works are located in the buildings numbered 1 and 3 Ashburton Place, at the corner of Somerset Street, in Boston.

A branch office for the Wachusett Department of the Water Works is maintained at Clinton, and for the Sudbury Department at South Framingham. Headquarters of the maintenance force of the Water

Works for the northern part of the Metropolitan District are maintained in the Glenwood pipe yard in Medford, where there are offices, shops, store-rooms and stables; and the maintenance force for the southern part of the District has headquarters in like buildings at the Chestnut Hill Reservoir.

Branch headquarters of the maintenance and repair forces of the Sewerage Works are maintained for the North Metropolitan System near the East Boston pumping station, and for the South Metropolitan System at the Ward Street pumping station and at the storage yard at Hough's Neck.

(3) CONVEYANCING.

The settlements made by the Board calling for the revision and bringing up to date of titles to real estate and the preparation of various instruments have been 20 in number. The settlements on account of Water Works were 16, and they affected 595.371 acres. Of the Water Works settlements, 5 were for damages for depreciation to land in Boylston, West Boylston and Sterling, comprising 482.12 acres, and 11 were for land purchased, 112.098 acres being purchased in fee, and easements being acquired in 0.253 of an acre.

Nearly the whole area of the land and easements acquired were about the Waushacum ponds in Sterling. After the settlements were effected takings were made of most of the lands acquired.

There were 4 settlements, affecting 1.062 acres, on account of the Sewerage Works, 1 for the High-level Sewer in Quincy and 3 for the Belmont extension sewer.

Other deeds and indentures have been prepared by the conveyancers, and they have been called upon from time to time to make investigations in answer to the inquiries from the engineering department and also for the Attorney-General's department in connection with suits.

II. METROPOLITAN WATER DISTRICT.

The Metropolitan Water District now comprises the cities of Boston, Chelsea, Everett, Malden, Medford, Melrose, Newton, Quincy and Somerville, and the towns of Arlington, Belmont, Hyde Park, Lexington, Milton, Nahant, Revere, Stoneham, Watertown and Winthrop, — in all, 9 cities and 10 towns. The District has

an area of 171.7 square miles, and its population, as of the date of July 1, 1908, the date upon which calculations for the Water Works are based, is estimated at 989,090.

The town of Swampscott, having an estimated population of 5,640, although it is outside of the Metropolitan Water District, is supplied with water under a contract made with the Board, terminating on December 31, 1908.

The city of Newton and the town of Hyde Park, however, though belonging to the District, do not take water from the Metropolitan sources, but still depend upon their own sources of supply.

III. METROPOLITAN WATER WORKS — CONSTRUCTION.

The total amount expended for construction, including real estate and other property acquired, and payment of claims on account of the Water Works, during the calendar year 1908, was \$217,129.47. Of this amount, \$116,581.36 was expended on account of the Wachusett Dam and Reservoir; \$2,098.65 on account of the Weston Aqueduct and Reservoir; \$4,430.54 for the improvement of the Wachusett watershed; \$52.55 on account of the diversion of the waters of the South Branch of the Nashua River; \$74,931.18 for construction in the Distribution Department; and the remainder, \$19,035.19, for administration and other expenses. The total amount expended on account of construction since the beginning of the Water Works in the year 1895 has been \$40,684,637.51.

(1) WACHUSETT DAM AND RESERVOIR.

(a) *Wachusett Dam.*

The construction work which has been done in connection with the Wachusett Dam during the past year has not been of great amount.

In the earlier part of the year the stop-planks required for use on the waste-weir were made; a railway track was laid on the bridge over the waste-weir; and a small hand car was supplied for transporting the stop-planks when required for use. The work of filling and pointing the joints of the ashlar facing of the up-stream side of the dam was completed to elevation 405, or 10 feet above the full-reservoir level.

(b) *Wachusett Reservoir.*

The work of repairing and reinforcing the North Dike had been substantially completed in the preceding year, there remaining to be placed only about 600 cubic yards of riprap on the slope of the dike. This was accomplished in January, and in the early spring the final grading and seeding of the portion of the dike which had been repaired was done by the day-labor force. The total cost of repairing and reinforcing the dike was \$57,950.82.

The reservoir was for the first time filled to the high-water mark on May 10, and subsequently, on May 30, during a heavy rain, the water rose to the elevation of 395.31, or a little more than 6 inches above the regular high-water level. For portions of a few days water flowed over the waste-weir.

The caving of the banks of the reservoir, especially along the south shore between the southerly end of the South Dike in Boylston and Worcester Street in West Boylston, and along a portion of the north shore in West Boylston and Boylston, when the reservoir was filling with water, required considerable additional stripping and removal of soil. This stripping was made for an aggregate length of 12,240 feet of shore line and from an area of about $3\frac{1}{2}$ acres.

(c) *Clinton Catholic Cemetery.*

The Board has been unable to bring to a termination the agreement made with the Roman Catholic Bishop of the Diocese of Springfield and the St. John's Catholic Cemetery Association, by which the land occupied by the old cemetery in Clinton was taken and the bodies removed to a new site purchased for the purpose of the Association in Lancaster. The Board has performed all the stipulations of the agreement so far as it has been able and has repeatedly declared its readiness, in accordance with the terms of the agreement, to pay to the Association the balance of the money, amounting to \$32,096.83, due from the Commonwealth, and also to convey to the Association the lands in Lancaster, to which the Commonwealth holds title, on receipt from the Bishop of a conveyance of the old cemetery lot and the release of all claims for damages.

(2) IMPROVEMENT OF WACHUSETT WATERSHED.

The appropriation for the improvement of the Wachusett watershed was limited to \$5,000, and consequently no work of large importance has been undertaken.

The buildings and dams on the sites of two mills upon the Stillwater and Quinepoxet rivers, which had been purchased by the Board, have been torn down, the ponds have been drained and the grounds have been cleaned and graded. Four dwelling houses in Clinton and West Boylston upon lands which had been taken by the Board have also been leveled, and the premises occupied by the various buildings near West Waushacum Pond in Sterling have been cleared and graded. Some cesspools and diverting ditches have been built in West Boylston and Sterling in order to prevent the entrance of objectionable drainage into the brooks tributary to the reservoir.

Surveys and plans have been made for improving the channel of the Stillwater River and also for draining a considerable tract of swamp land adjacent to the river in the town of Sterling. Record plans have been made in order to show the location of the ditches which have been constructed in swamps upon the watershed.

(3) DISTRIBUTION SYSTEM.

(a) Arlington Pumping Station.

Although the Arlington pumping station had been completed in the preceding year, various small additions have been required in order to put the station into working order. The grounds about the station have also been graded and planted with shrubbery.

The Allis-Chalmers pumping engine which had been installed in the previous year has been in constant use, but the official duty trials were had but recently. The duty developed by the engine was less than guaranteed, so that a considerable sum was deducted from the contract price, but the engine is entirely satisfactory for the purposes for which it is required.

The second engine, of the Blake & Knowles pattern, was installed in the station early in the year and has since been in operation. The official tests show that the required duty has been attained.

(b) *New 48-inch Supply Main for Boston Low-service District.*

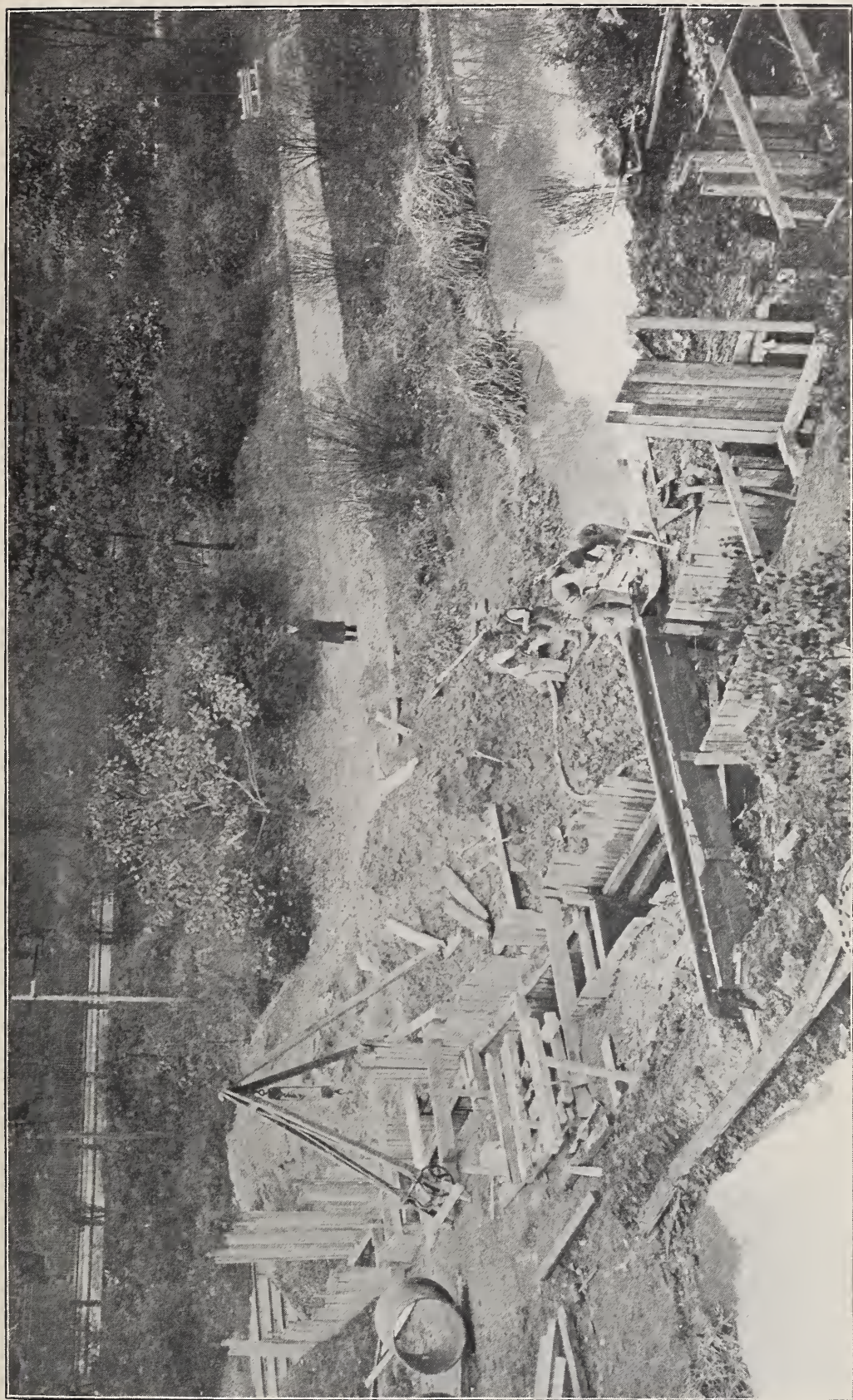
The Legislature of 1908, in accordance with the recommendation of the Board, authorized the laying of a new 48-inch main from a point near Chestnut Hill Reservoir through Beacon Street, Harvard Street and Longwood Avenue, to the boundary line between the town of Brookline and the city of Boston, for which an appropriation of \$190,000 was made.

A contract for the necessary pipe was made in the latter part of the summer, and later one was made for the laying of the main. The work under the contract for pipe laying was directly begun, and at the end of the season the portion of the line extending from the Riverway near Longwood Avenue in Boston to Coolidge Corner in Brookline, a distance of 3,471 feet, had been laid and connected with the Boston pipes. The work upon the main will be resumed as early as possible in the current year, and its completion to the Chestnut Hill Reservoir is expected by the end of the summer. The sum of \$64,569.27 was expended during the year under the appropriation for this work.

(4) ACQUISITION OF LANDS AND SETTLEMENTS FOR LANDS
ACQUIRED.

The Board acquired during the past year 110.587 acres in fee, and easements in 0.253 of an acre. Of the land acquired in fee 82.50 acres were situated about the Waushacum ponds in Sterling, 8.73 acres about the Wachusett Reservoir in Clinton and West Boylston, and 0.137 of an acre near the Sudbury Reservoir in Southborough. The easements acquired were in land situated in Southborough.

The total area of all the lands acquired for the Metropolitan Water Works since the beginning of operations in the year 1895 amounts to 16,944.417 acres, or 26.47 square miles. The number of takings of land made during the year was 5, all of lands supposed to have been already acquired by deed.



LAYING NEW 48-INCH MAIN ACROSS THE RIVERWAY IN BOSTON AND BROOKLINE.

List of Takings for Metropolitan Water Works for the Year 1908.

No.	LOCATION AND DESCRIPTION.	Former Owner.	Recorded.	Purpose of Taking.
122	Westborough, — southeast of East Main Street and both sides of the Boston & Albany Railroad, with right of way to East Main Street. Area, 14.96 acres in fee.	William T. Forbes.	1908. April 30.	Improvement of Cedar Swamp.
123	Boylston and Berlin, — location of railroad, extending easterly from location already taken in Boylston to new location in Berlin. Area, 5.02 acres in fee, and the right, title and interest of railroad companies in 12 acres.	Central Massachusetts Railroad and Boston & Maine Railroad.	July 13.	Wachusett Reservoir.
124	Sterling, — on Waushacum Street, and the Sterling Center road, and Stillwater River. Area, 81.79 acres in fee.	Henry B. Stone and Alice Harlow.	July 24.	Improvement of Wachusett watershed.
125	Brookline, — from Chapel Street across the railroad location to the Brookline Parkway. Area, easements in 0.018 acre.	Boston & Albany Railroad.	Sept. 8.	Pipe line.
126	Southborough, — 10 parcels adjoining or near the Sudbury Reservoir, previously conveyed to the city of Boston or to the Commonwealth. Area, 114.869 acres in fee.	Nahum F. Brewer, city of Boston, town of Southborough, Noah Willard, De Clinton Nichols, Nancy L. Ransom, Edna R. Hess, Charles A. Woods, James F. Shaw, James F. Chickering and Robert M. and Harry Burnett.	Dec. 31.	Sudbury Reservoir.

Settlements under purchases and takings of land, for all purposes of the Water Works, have been effected in the past year in 9 cases, and for an aggregate of 113.012 acres, with the buildings thereon. Of these cases, 1 was on account of the Wachusett Reservoir, 1 on account of the Weston Aqueduct, 3 for the improvement of the Wachusett watershed, 1 for the Northern Extra high-service pumping station in Arlington, 1 on account of the Sudbury Reservoir and 1 for the improvement of Lake Cochituate. The sums paid in all these settlements during the year 1908 have amounted to \$18,448.39. In 1 of these cases the settlement has been the result of suit, and the total amount paid in this, the only court settlement during the year 1908, was \$1,763.39.

Since the beginning of operations upon the Metropolitan Water Works, the number of settlements effected on account of the acquisition of lands for the purposes of the Water Works, including the

works of water supply acquired from the city of Boston on January 1, 1898, has amounted to 890, and under them the Board has acquired rights, in fee or easements, in 16,651.128 acres, or 26.017 square miles, for which an aggregate of \$18,276,297.11 has been paid. Only 52 of these cases have been settled by judgments obtained in court, and the total amount paid under these judgments has been \$1,392,033.54, or less than 8 per cent. of the whole amount paid.

Settlement has been effected with all owners, who have made claims for damages within the time allowed by the statute, of lands acquired either in fee or in easement for the Metropolitan Water Works since the beginning of operations in 1895, except in 3 cases, involving 1.176 acres. The settlements do not include the 69.75 acres in Lancaster, the title to which stands in the Commonwealth and which the Board stands ready to convey to the St. John's Catholic Cemetery Association, or 40 acres in 2 parcels, owners of which are unknown, and 12.882 acres in 8 parcels for which the owners have made no claim within the time allowed by the statute.

Not including the settlement with the city of Boston, which was effected by agreement out of court, and the settlement with the cities of Malden, Medford and Melrose for Spot Pond and surrounding lands, which was made upon the basis of an award by commissioners, the Board has obtained settlement by voluntary agreement with $\frac{17}{18}$ of all the owners of the lands acquired, and almost $\frac{13}{14}$ of the total amount of money paid in settlements was under voluntary agreement with the owners.

The above purchases and takings do not include settlements for diversion of water, depreciation and other damages connected with lands not acquired, and in which no fee or easement has been taken.

Summary of Land Settlements for Water Works to December 31, 1908.

LOCATION.	FOR THE YEAR 1908.			FROM BEGINNING OF WORK.		
	Area in Acres.	Number of Settlements.	Payments.	Area in Acres.	Number of Settlements.	Payments.
<i>Wachusett Reservoir.</i>						
Berlin,	-	1	\$950 00	16.700	442	\$2,959,309 10
Boylston,	-			4,003.116		
Clinton,	1.000			1,277.284		
Holden,	-			167.000		
Sterling,	-			797.987		
West Boylston,	-			1,683.497		
Total,	1.000	1	\$950 00	7,945.584	442	\$2,959,309 10
<i>Improving Wachusett Watershed.</i>						
Holden,	-	3	\$12,820 00	151.340	14	\$148,890 00
Sterling,	94.500			332.240		
West Boylston,	7.730			72.160		
Total,	102.230	3	\$14,370 00	555.740	14	\$148,890 00
<i>Wachusett Aqueduct.</i>						
Berlin,	-	-	-	47.815	70	\$81,677 08
Clinton,	-			12.310		
Marlborough,	-			51.530		
Northborough,	-			89.000		
Southborough,	-			108.660		
Total,	-	-	-	309.315	70	\$81,677 08
<i>Sudbury Reservoir.¹</i>						
Marlborough, . . . . .	.450	2	\$675 00	752.420	155	\$658,993 75
Southborough, . . . . .	.137			2,019.217		
Total, . . . . .	.587	2	\$675 00	2,771.647	155	\$658,993 75
<i>Improving Sudbury Watershed.</i>						
Ashland,	-	-	-	.630	41	\$16,522 16
Marlborough,	-			.800		
Northborough,	-			178.049		
Sherborn,	-			1.000		
Southborough,	-			4.829		
Westborough,	-			205.487		
Total,	-	-	-	390.795	41	\$16,522 16

¹ Including settlements made by city of Boston.

Summary of Land Settlements for Water Works, etc. — Continued.

LOCATION.	FOR THE YEAR 1908.			FROM BEGINNING OF WORK.		
	Area in Acres.	Number of Settlements.	Payments.	Area in Acres.	Number of Settlements.	Payments.
<i>Clinton Sewerage System.</i>						
Clinton,	-	}	-	5.315	}	\$37,794 40
Lancaster,	-		129.835			
Total,	-	-	-	135.150	36	\$37,794 40
<i>Weston Aqueduct.</i>						
Framingham,	-	}	1	107.335	}	\$188,925 35
Newton,	-			1.308		
Southborough,	-			.810		
Wayland,	1.960 ¹			75.259		
Weston,	-	}	1	295.915	}	\$188,925 35
Total,	1.960			480.627			91
<i>Distribution System.</i>						
Arlington, . . . . .	.015	}	1	1.911	}	\$172,806 85
Boston,	-			1.359		
Brookline,	-			.051		
Malden,	-			.158		
Medford,	-			3.251		
Newton,	-			5.147		
Quincy,	-			5.224		
Revere,	-			.404		
Somerville,	-			.009		
Stoneham,	-			19.409		
Total, . . . . .	.015	1	\$90 00	36.923	36	\$172,806 85
<i>Improving Lake Cochituate.</i>						
Natick,	2.630	}	1	5.580	}	\$2,200 00
Wayland,	4.590			4.590		
Total,	7.220	1	\$600 00	10.170	2	\$2,200 00
<i>Spot Pond Water Works (Taking of January 1, 1898).</i>						
Medford,	-	}	-	.630	}	\$1,214,523 63 ²
Stoneham,	-			216.000		
Total,	-	-	-	216.630	1	\$1,214,523 63

¹ Does not include temporary rights in .480 acre.² Includes \$749.71 paid city of Malden for supplies not part of award.

Summary of Land Settlements for Water Works, etc. — Concluded.

LOCATION.	FOR THE YEAR 1908.			FROM BEGINNING OF WORK.		
	Area in Acres.	Number of Settlements.	Payments.	Area in Acres.	Number of Settlements.	Payments.
<i>Spot Pond Improvement (Takings of August 5, 1899, and June 2, 1902).</i>						
Medford,	-	}	-	41.447	}	\$25,705 99
Stoneham,	-		-	13.100		
Total,	-	-	-	54.547	1	\$25,705 99
<i>Boston Water Works¹ (Taking of January 1, 1888).</i>						
Arlington,	-	}	-	1.586	}	\$12,768,948 80 ²
Ashland,	-			652.124		
Boston,	-			160.630		
Framingham,	-			663.460		
Hopkinton,	-			654.729		
Marlborough,	-			30.552		
Medford,	-			25.140		
Natick,	-			436.223		
Needham,	-			31.695		
Newton,	-			78.308		
Sherborn,	-			40.385		
Somerville,	-			12.426		
Southborough,	-			17.168		
Wayland,	-			177.875		
Wellesley,	-			139.115		
Westborough,	-			545.912		
Winchester,	-			76.094		
Woburn,	-			.578		
Total,	-	-	-	3,744.000	1	\$12,768,948 80
Aggregates,	113.012	9	\$18,448 39	16,651.128	890	\$18,276,297 11

¹ Estimated areas.

² Includes interest.

The settlements above enumerated include all lands acquired for which a complete settlement has been made. About 116.22 acres of the lands acquired and settled for have been subsequently sold and conveyed by the Board.

The tables of settlements for lands acquired do not include 50.77 acres previously owned by the Commonwealth and the areas of streets.

(5) CLAIMS AND SETTLEMENTS FOR LOSS OF BUSINESS.

For injury to business caused by the carrying out of the Metropolitan Water Act in the towns of Boylston and West Boylston and in portions of the towns of Sterling and Clinton, settlements were made during the year in 5 cases, the amount paid being \$2,070.

The number of claims of this class settled since the beginning of the Metropolitan Water Works has been 331, and the total sum paid on account of such claims has been \$156,049.18. All of these claims except 24 have been settled outside of the courts.

(6) CLAIMS AND SETTLEMENTS FOR LOSS OF EMPLOYMENT.

No claims for loss of employment by residents of West Boylston have been filed during the year. This class of claims seems to be finally disposed of.

The whole number of settlements for such claims effected since the beginning of the operations of the Board has been 477. The total amount paid on account of these claims has been \$85,959.65. All of the claims with the exception of 3 were settled without resort to the courts.

(7) CLAIMS AND SETTLEMENTS FOR DEPRECIATION OF REAL ESTATE.

Settlements for depreciation in the value of real estate not taken by the Board were effected in 5 cases: 2 on account of lands situated in the town of West Boylston amounting to \$533.33, 1 on account of lands situated in Boylston amounting to \$150, 2 on account of lands situated in Sterling amounting to \$6,500, making a total for the year of \$7,183.33. The two Sterling and one West Boylston cases were settled in court by voluntary agreement. The Boylston and one of the West Boylston cases were settled by agreement out of court.

The total number of claims for depreciation settled up to December 31, 1908, has been 287, and the total amount paid thereunder has been \$285,988.24. All of these claims except 45 were settled out of court.

(8) CLAIMS ON ACCOUNT OF DIVERSION OF WATER.

There have been no claims settled during the year for damages for the diversion of water. The total sum paid under settlements and judgments arising under claims made on account of the diversion of water, since the beginning of the construction of the Water Works, has been \$1,138,069.67.

The sums enumerated as paid in these and in the preceding cases do not include amounts paid for expert services and court expenses.

IV. WATER WORKS — MAINTENANCE.

Dexter Brackett, the Chief Engineer of the Water Works, has had the general supervision not only of construction but also of the maintenance and operation of all of the Water Works in the Metropolitan System. Under his direction there have been employed as his assistants: Elliot R. B. Allardice, Superintendent of the Wachusett Department; Charles E. Haberstroh, Superintendent of the Sudbury and Cochituate Works and of the portion of the Weston Aqueduct above the Weston Reservoir; William E. Foss, Division Engineer having special charge of matters connected with pipe lines; Alfred O. Doane, Division Engineer in special charge of work at pumping stations. George E. Wilde, Superintendent in charge of the Weston Reservoir and the remainder of the Weston Aqueduct and of all the reservoirs and pipe lines within the Metropolitan District, died in July, having faithfully served the Board since the operation of the Water Works began on January 1, 1898. Samuel E. Killam was promoted from the engineering force to fill the vacant position. Arthur E. O'Neil has continued to act as Superintendent of the several pumping stations.

(1) OPERATION OF WORKS.

The Board is now maintaining five pumping stations, two at Chestnut Hill, one each at Spot Pond, Arlington and West Roxbury, the two sewerage pumping stations, one upon the Pegan Brook at Natick and the other at Clinton, the ten storage reservoirs in the Cochituate, Sudbury and Wachusett watersheds, ten distributing reservoirs and standpipes within the Metropolitan District, the Cochituate, Sudbury and Wachusett aqueducts, the Clinton, Marlbor-

ough, Pegan and Sterling filter-beds, and the 84.65 miles of distributing main pipes. Attached to these are the various pipe yards, gate-houses, siphon and terminal chambers and other structures, dwellings for attendants and various other buildings used or held for operating purposes. The Mystic pumping station and Mystic Aqueduct have not been in active operation during the year.

(2) STORAGE RESERVOIRS.

The following are the reservoirs maintained for the storage of water collected for the Metropolitan Water District:—

	Capacity in Gallons.
Cochituate watershed :—	
Lake Cochituate, including Dudley Pond,	2,242,400,000
Sudbury watershed :—	
Sudbury Reservoir,	7,253,500,000
Framingham Reservoir No. 1,	287,500,000
Framingham Reservoir No. 2,	529,900,000
Framingham Reservoir No. 3,	1,180,000,000
Ashland Reservoir,	1,416,400,000
Hopkinton Reservoir,	1,520,900,000
Whitehall Reservoir,	1,256,900,000
Farm Pond,	167,500,000
Wachusett watershed :—	
Wachusett Reservoir,	64,968,000,000
Total,	80,823,000,000

These reservoirs have a total normal capacity of 80,823,000,000 gallons. Individual reservoirs have at certain periods actually held in storage quantities exceeding their normal capacities. The largest quantity held in storage at any one time during the year by all of the reservoirs was 80,542,000,000 gallons.

The heavy rains at the end of the preceding year had made the quantity of water in storage at the beginning of the year 1908 much larger than at any previous time, the reservoirs then containing 65,856,900,000 gallons. During the earlier months of the year there was a continual gain in the quantity in storage, so that from May 1 until June 1 all the reservoirs were practically full, the maximum quantity of 80,542,000,000 gallons having been reached on May 24. Owing to the small amount of rainfall during the succeeding seven months of the year there was a continual loss in storage, amounting to 21,547,000,000 gallons, so that on January



OVERFLOW FROM RESERVOIR DOWN THE WASTE CHANNEL.



WATER RUNNING DOWN WASTE CHANNEL INTO RIVER BELOW THE DAM.

1, 1909, the total quantity was but 58,890,300,000 gallons, or 6,966,-600,000 gallons less than that contained in the reservoirs at the beginning of the year. This smaller quantity of water in storage on January 1, 1909, would, however, be sufficient, even at the present rate of consumption, to supply, without additional rainfall, the demands of the District for a period considerably exceeding one year.

At the beginning of the year the Wachusett Reservoir had been filled up to a height 10.69 feet below the high-water level, but there was a continuous rise in the elevation of the water during the early months and the high-water level was attained on May 10. By the use of flashboards the elevation of 395.31 was reached, when the reservoir contained 65,197,200,000 gallons. On some days between March 10 and June 2 water was allowed to run over the waste-weir and down the waste channel into the river below the dam. Afterwards the water was almost constantly drawn down, and on December 31 the reservoir contained only 46,176,000,000 gallons, having an elevation of 379.87, or 15.13 feet below the high-water level.

Various improvements have been effected in connection with the maintenance work upon the reservoir. Additional pipe wells have been driven through the soil of the North Dike and into the underlying sand in order to obtain measurements of the ground water in different parts of the dike. Portions of the slopes of both the north and south dikes have been given dressings, or plowed and seeded with grass. Considerable cleaning was done on that portion of the reservoir bottom which was above the water level of 1907, and the bushes and roots and other organic matter, which had been left remaining, were removed as the water subsided. The strong action of the waves had impaired the riprap along portions of the shore and also some of the higher embankments which skirted the reservoir, so that considerable protection and reinforcement of riprap has been found necessary. It was found that the embankments of the railroad which passes through the extreme upper end of the reservoir at Oakdale had suffered a considerable settlement by being submerged on the filling of the reservoir. The restoration of the embankments and of the tracks to grade was done by the Boston & Maine Railroad under an arrangement with the Board, the expense being borne by the Commonwealth.

At various places on the marginal land fences have been built upon the line between the Commonwealth's land and that of the

adjacent owners, each side paying one-half of the expense. The various dwelling houses and other buildings connected with the reservoir work and the Clinton filter-beds have required considerable repairs.

The sale of the standing grass upon the lands of the Commonwealth surrounding the reservoir yielded the sum of \$2,442.75.

Sudbury Reservoir was, by the introduction of the water from the Wachusett Aqueduct, kept nearly full or overflowing during all but about a month and a half of the year, when the water was drawn down somewhat for a special purpose. During the larger part of the months the water was permitted to flow over the crest of the dam into Framingham Reservoir No. 3.

By arrangement made with the selectmen of the town of Southborough an earth dam was built across an arm of the reservoir, which, 400 feet in length with a maximum width of 60 feet, is situated east of Maple Street and on the northeasterly portion of the reservoir, in order to afford a swimming pool for the inhabitants of the town. Water is admitted to the pool from the reservoir and is carried by a pipe to a filter-bed, whence it flows into a brook leading to Framingham Reservoir No. 3. The town purchased the land for the location of the filter-beds and paid the expense of all pipes and other materials used in building the pool and filter-beds. This action was taken by the Board in consideration of the fact that the waters of this town had been entirely taken for the Metropolitan Water Works.

Framingham Reservoir No. 3, which receives the overflow from the Sudbury Reservoir, was kept full or nearly full during the year.

The water in Lake Cochituate was kept at nearly high-water mark during the first half of the year, and subsequently was but little drawn down, the water standing at the end of the year only 2.58 feet below high water. The replacing of land bounds which had been removed and the setting of bounds in the places where none had existed, in order to mark the line of the Commonwealth's property surrounding the lake, was completed, so that now the marginal line is throughout well marked by stone bounds, although fences have not been erected between the Commonwealth's lands and those of private owners.

Various minor repairs and improvements have been effected in the different storage reservoirs.

An average of 107,502,000 gallons of water per day was drawn from the Wachusett Reservoir, but all of this was conveyed through the Wachusett Aqueduct into the Sudbury Reservoir, from which and from Framingham Reservoir No. 3 (which receives the overflow from the Sudbury Reservoir) the waters of the Wachusett system and of this portion of the Sudbury System are conveyed into the Metropolitan District. An average of 29,965,000 gallons per day was drawn directly from the Sudbury Reservoir through the Weston Aqueduct, and from Framingham Reservoir No. 3 an average of 94,256,000 gallons per day was drawn through the Sudbury Aqueduct. In addition, an average of 4,027,000 gallons per day was drawn from Lake Cochituate through the Cochituate Aqueduct. The Spot Pond drainage area also furnished 82,570 gallons per day.

No drafts to supply the district were made during the year from Framingham Reservoir No. 2 and the Ashland, Hopkinton and Whitehall reservoirs, a small quantity drawn from Framingham Reservoir No. 2 being used in cleaning the Sudbury Aqueduct. All of these reservoirs were kept substantially full throughout the year, although their water was not used for the district, the water received from the other sources being of a preferable quality. Framingham Reservoir No. 1 and Farm Pond are seldom used for the direct supply of the District, though the town of Framingham, during the greater part of the year, has drawn a large portion of its supply from the filter gallery built in connection with Farm Pond.

(3) DISTRIBUTING RESERVOIRS.

There are eight distributing reservoirs and two standpipes, all situated within the Metropolitan District, having a total capacity of 2,381,230,000 gallons, as follows:—

	Capacity in Gallons.
Spot Pond,	1,791,700,000
Chestnut Hill Reservoir,	300,000,000
Weston Reservoir,	200,000,000
Fells Reservoir,	41,400,000
Mystic Reservoir,	26,200,000
Waban Hill Reservoir,	13,500,000
Forbes Hill Reservoir,	5,100,000
Bear Hill Reservoir,	2,450,000
Arlington Standpipe,	550,000
Forbes Hill Standpipe,	330,000
Total,	2,381,230,000

These reservoirs are kept substantially full, not only for facilitating the distribution of water to the various portions of the Metropolitan District, but also in order to afford protection in case of emergency. If, from accident or otherwise, the storage reservoirs were all cut off from connection with the District there would be held in storage seldom less than 15 or 16 days' supply.

There have been the ordinary repairs as well as the regular maintenance work upon all of the reservoirs and the buildings and grounds which are connected with them. The large number of people who visit the grounds of the Chestnut Hill Reservoir, especially on evenings, Sundays and holidays, necessitated larger expenditures for the keeping of these grounds in order and for maintaining them in a sanitary and orderly condition, as well as in a condition which shall afford a proper use by the public. Considerable improvements have been required in the house occupied by the Superintendent of Pipe Lines and Reservoirs, near the Mystic pumping station.

The presence of large numbers of gulls and ducks upon the reservoirs, especially Spot Pond and Chestnut Hill Reservoir, has become threatening to the purity of the water. The attempts which have been made to drive away these birds have not been successful, and the matter has been referred to the attention of the Legislature, as appears in the report to the Legislature already presented.

(4) AQUEDUCTS.

The Wachusett Aqueduct and the Sudbury Aqueduct have been in operation during the year, having been closed as necessary for cleaning the aqueducts. The former was in operation on 310 days during the year and the Sudbury Aqueduct on 360 days. The Weston Aqueduct was in service on every day of the year, no cleaning having been required. The Cochituate Aqueduct was in use on 108 days.

Owing to the disintegration by frosts and to other causes, somewhat extensive repairs were required upon the masonry of the Waban bridge, which supports the Sudbury Aqueduct, the bridge having been constructed over thirty years ago. There has been the ordinary maintenance work performed upon the aqueducts and the grounds which are occupied in connection therewith.

(5) PUMPING STATIONS.

All the water supplied to the Metropolitan District through the Sudbury and Cochituate aqueducts is pumped at the high and low service pumping stations at the Chestnut Hill Reservoir. The remainder of the water supplied was delivered to the District by gravity through the Weston Aqueduct. Thus 76 per cent. of the water supplied is pumped at the two stations at Chestnut Hill Reservoir and the remaining 24 per cent. is supplied by gravity either to Spot Pond or to the main pipe lines. From the Chestnut Hill low-service station water is pumped not only to the lower portions of the District but also to Spot Pond, and from the Spot Pond station as well as from the Arlington and West Roxbury stations water is pumped into the higher regions embraced within the District.

The total quantity of water pumped during the year was 39,210,596,400 gallons, which was 2.6 per cent. more than the quantity pumped during the preceding year. The total cost of operating all the stations was \$119,201.12, or \$3.044 per million gallons pumped, — an increase of \$0.107 over the cost of the preceding year. A part of this increase is due to the larger amount paid for labor, the increase in wages made in the preceding year having applied only to a portion of the year. The cost of fuel was also slightly greater than in the preceding year.

The total amount of coal purchased during the year for use at the various stations was 12,675.02 gross tons. Of this total, 8,536.65 tons were bituminous, 382.99 tons anthracite, 2,988.95 tons buckwheat anthracite, and 766.43 tons were anthracite screenings. The average price per gross ton for the bituminous coal at the several stations varied, chiefly on account of differences in cost of transportation, from \$3.93 to \$5. The average cost of the anthracite coal was \$7 per gross ton, of the buckwheat anthracite \$2.77, and of the anthracite screenings \$2.33.

Tests are constantly made at the different stations not only to determine the heating value of the coals and the percentage of volatile matter and ash contained, but also to determine the viscosity, specific gravity and burning point of the oils which are used. During the year 134 samples of coal and 32 samples of oil were thus tested.

The cost per million gallons of water raised one foot was, for the Chestnut Hill high-service station, \$0.030; for the Chestnut Hill low-service station, \$0.032; for the Spot Pond station, \$0.037; for the Arlington station, \$0.114; and for the West Roxbury station, \$0.205. The average cost at all the stations of raising one million gallons of water one foot high has been \$0.0351, — an increase of nearly 7 per cent. over the average cost of the previous year. There has been a considerable increase in the quantity of water pumped at all of the stations except that at Spot Pond, where there was a considerable decrease, owing to the decreased consumption of water in Melrose and in other portions of the high-service district.

As the new Blake engine was not until February 15 delivered and put into operation in the new Arlington pumping station building, the engine in the old station was kept ready for use until that date. Subsequently the old station was torn down and the grounds graded and seeded. There was a large increase, amounting to more than 20 per cent., in the quantity of water pumped at this station during the year, an increase which was almost entirely due to the increase in the quantity consumed in the high-service district of Arlington.

There has been an increase of more than $7\frac{1}{2}$ per cent. in the quantity pumped at the West Roxbury pumping station. It has been necessary at times to operate both of the pumps at this station to their full capacity in order to supply the demands made upon this portion of the system. It was originally contemplated that the high-service district not only of West Roxbury and of Milton but also of Hyde Park and Newton would have to be provided for, and it has been expected that for the permanent supply of these districts a pumping station will have to be erected. As no supply has been called for by either Hyde Park or Newton the arrangement was made temporarily with the city of Boston by which a small pumping station and machinery in West Roxbury belonging to the city should be leased and operated by the Board. The present pumping plant is now taxed to its utmost safe capacity. As the arrangement must necessarily last some time longer, it is proposed to construct a small addition to the present pumping station and to install there the engine formerly used by the city of Melrose at Spot Pond, which is now stored by the Board, and to supply a new boiler. It is estimated that the entire expenditure will not exceed \$7,000.

(6) PIPE LINES.

The pipe lines maintained by the Board, through which the water is distributed to the various cities and towns, aggregated in length at the end of the year 84.65 miles, and the length of the various mains 4 inches and more in diameter connected with the Metropolitan system, but owned and operated by the several cities and towns which were supplied by the works, was 1,484.2 miles.

There were two breaks during the year, one upon the high-service main in West Roxbury and the other in a main in Somerville. Both of the breaks seem to have been due to a settlement of the pipes where they had been laid in trenches and not properly protected, so that the pipe was allowed to rest upon points of a rocky ledge. In both cases considerable volumes of water escaped and the surfaces of the streets in the vicinity were washed. There were 20 smaller leaks in the pipe lines maintained by the Board, due to defective leaded joints.

It has been necessary to relocate the 36-inch main crossing Washington Street at Forest Hills in West Roxbury, on account of the construction work of the Boston Elevated Railway Company, but the cost of this work, amounting to \$2,473.51, was paid by the Company.

The ordinary general repairs have been required during the year, and some additional pressure regulators and recording gages have been called for. The care and readings of the Venturi meters and of the various gages required to determine and regulate the consumption and flow of water in the different municipalities add considerable to the work of maintenance.

(7) SEWERAGE AND FILTRATION WORKS.

(a) *Clinton Sewerage Works.*

The quantity of sewage received at the Clinton pumping station from the Clinton sewers was less by about 9 per cent. than that received during the preceding year, the decrease in quantity being undoubtedly due principally to the smaller amount of rain which fell during the year, inasmuch as after heavy rainfalls great quantities of ground water reach the sewers of the town. The total quantity of sewage pumped upon the filter-beds was 787,000 gallons.

The character of the effluent from the filter-beds has not been satisfactory for several years, and during the past two or three years investigations and experiments have been conducted under the supervision of the State Board of Health for the purpose of increasing the efficiency of the filters. It seemed probable that the quantity of sewage applied to individual beds had been too great to permit the proper oxidation of the sewage, so that organic matter had accumulated in the interstices of the filtration material. Other causes of the inefficiency were thought to be the uneven distribution of sewage on the surface of the beds and the insufficient underdrainage. An attempt has been made to remedy these troubles during the year. The eight settling basins into which the sewage is first pumped have been used continuously in rotation during a part of the time, two of the basins being used together for four weeks and at other times for one week. The filter-beds have been used in rotation continuously, each receiving sewage for about one-half hour once in two days. The laying of additional underdrains has been begun, while portions of the old underdrains have been cleaned and relaid. The area of the filter-beds is also to be increased by utilizing about three acres of additional ground.

The total cost of pumping the sewage was \$3,158.87, which is considerably less than the cost of last year, — a reduction due not only to the smaller quantity of sewage, but also to the fact that fewer repairs were found necessary. The cost per million gallons pumped was \$10.96, as against \$14.47 last year, and the cost per million gallons of sewage raised one foot was \$0.22, as against \$0.28 last year. There was, however, a slight increase in the cost of maintenance of the filter-beds, which amounted to \$3,147.87, the cost per million gallons treated being \$10.92.

The sludge accumulating in the settling basins was in the earlier portions of the year, as heretofore, given to the neighboring farmers, but later it was used as a fertilizer upon the lands about Wachusett Reservoir and upon the slopes of the South Dike.

(b) *Marlborough Filter-beds.*

The basin and filter-beds which have recently been constructed to receive any overflow which might come from the Marlborough main sewer during freshets showed a successful operation, and there was no overflow from them or from the Marlborough Brook filter-beds into the reservoir during the year.

(c) Pegan Filtration Works.

The total quantity of water pumped upon the Pegan filter-beds was 265,725,000 gallons, of which 173,448,000 gallons were received from the Pegan Brook and 92,279,000 gallons from the intercepting ditch which collects the water formerly draining into that part of Lake Cochituate which was called the Pegan Brook Meadow. The pumping station was in operation on 179 days and the amount of sewage daily pumped was 766,000 gallons.

An improvement was effected in the receiving reservoir, and the pumping station was given a complete painting.

The cost of operating the pumping station and of the maintenance of the filter-beds, grounds and ditches was \$2,740.08, a cost per million gallons treated of \$10.31, which is a slight increase over the cost of last year, owing to the more thorough cleaning which was required.

(8) SANITARY INSPECTION AND WORK.

William W. Locke, C.E., has had the help of two assistants in the sanitary inspection of the watersheds. In addition, a force, varying according to the time of the year from 3 to 12 men, has been employed to patrol the several reservoirs in order to protect the property of the Commonwealth and to enforce the regulations of the Board for the prevention of the pollution of the water.

There were but 4 cases of typhoid fever reported in the several towns upon the Wachusett watershed, and upon the Sudbury and Cochituate watersheds there were 24 cases of typhoid fever, the number in all the watersheds being less than that of last year. There was an epidemic of dysentery, however, in Natick, which resulted in 20 deaths out of 118 cases. There were 3 cases, but no deaths, reported in South Framingham. In all of the cases precautions were at once taken to prevent any pollution of the water supply, and no such pollution resulted so far as known.

The number of premises upon the Wachusett watershed inspected during the year was 1,458. These premises were inspected for the purpose of ascertaining the number of cesspools and the condition of the cesspools and of the privies, sink drainage, manure heaps and manufacturing wastes. Of the total number of premises inspected 1,363 were reported as satisfactory at the end of the year and 95 cases pronounced "unsatisfactory." The term unsatisfactory was

applied not only to cases producing a pollution of the water supply, but also to cases where, under most unfavorable conditions, there might be wash from privies or direct sink drainage or entrance of manufacturing wastes, including cases where attempts had been made for purification. Remedies for defects which were found were effected in 17 cases and 7 cases were partially remedied.

The number of cases inspected upon the Sudbury and Cochituate watersheds was 7,542. Of these, 7,224 were found to be in satisfactory condition and 318 were reported "unsatisfactory" at the end of the year. Upon the Sudbury watershed 51 cases were remedied by sewer connection, and 71 upon the Cochituate watershed were so remedied. Remedies were effected in 10 other cases upon the two watersheds, and partial remedies were made in 22 cases, while there were 106 cesspools abandoned on account of sewer connections.

An arrangement was entered into with the selectmen of the town of Framingham for the construction of a covered channel in place of the open ditch which had been formerly used for the flow of water from Farm Pond to Beaver Dam Brook, and also for cleaning out and improving the brook channel for a distance of 2,700 feet. This work of removing a sluggish ditch which had during recent years collected much objectionable refuse, and also of improving the channel of Beaver Dam Brook, was substantially completed, and under the arrangement the Board has agreed to pay \$2,500 on its part toward accomplishing the desired results.

The drainage ditches in the swamps, having on the three watersheds a length exceeding 36 miles, have been cleaned, and where required have been repaved and otherwise repaired. As a result of the construction and operation of these ditches the color of the water flowing from the larger swamps has greatly improved.

A lot of land in South Framingham, which had been for several years used as a dump for refuse material, had required constant inspection for the purpose of preventing the dumping of objectionable matter in proximity to Beaver Dam Brook, although the dump was about two miles from the outlet of the brook into Lake Cochituate. Arrangements have finally been made with the owners of the land by which no objectionable material will be dumped in the immediate vicinity of the brook where any pollution would be caused.

For the cutting of ice on Framingham reservoirs Nos. 2 and 3

and upon the Sudbury and Whitehall reservoirs and Dudley and Waushacum ponds permission is made necessary, and a notice of the time and place of the cutting proposed is required. Agents of the Board are detailed to inspect the work, and a fee not exceeding \$5 a day is imposed. This fee, however, may be divided between various parties who are doing the work at the same time and at places near together.

Samples of water collected from the various storage and distributing reservoirs and their various feeders are sent at semi-monthly or monthly periods to the State Board of Health for chemical analysis. The water from the various reservoirs is also examined microscopically and for color, odor, taste and turbidity at the laboratory of the Water and Sewerage Board as often as once a week, and a monthly examination is in like manner made of the water from the various main feeders of the water system. Constant biological examinations are also made in the laboratory of the water taken from the various sources of supply. The laboratory of the Board has made during the past year 2,459 microscopical, 1,215 biological and 8 chemical examinations.

In accordance with the policy adopted in the year 1906 and continued in 1907, boating was permitted during the past year upon the southerly and middle sections of Lake Cochituate under restrictions and regulations for the protection of the water from consequent pollution. No boating or fishing, however, was allowed upon the northern section of the lake, from which the water is delivered directly into the Cochituate Aqueduct. A further condition was made that neither the owner of the boat registered nor any licensee should use the boat in connection with any camp or tent or any structure temporarily set up on land adjacent to the marginal land of the Commonwealth. It was provided that boats might be used not only by the owner who received the registration but also by such relatives as properly constituted members of the owner's family. No such licenses for use of a boat were granted to children under the age of sixteen years. It was distinctly made a condition of the registration that in all cases the owner or a licensee should be in charge of the boat when in use, although the rule did not prohibit others from accompanying the owner or licensee. It was also determined to grant no licenses to motor or sail boats unless they had received registration the previous years. As in previous years, registration was

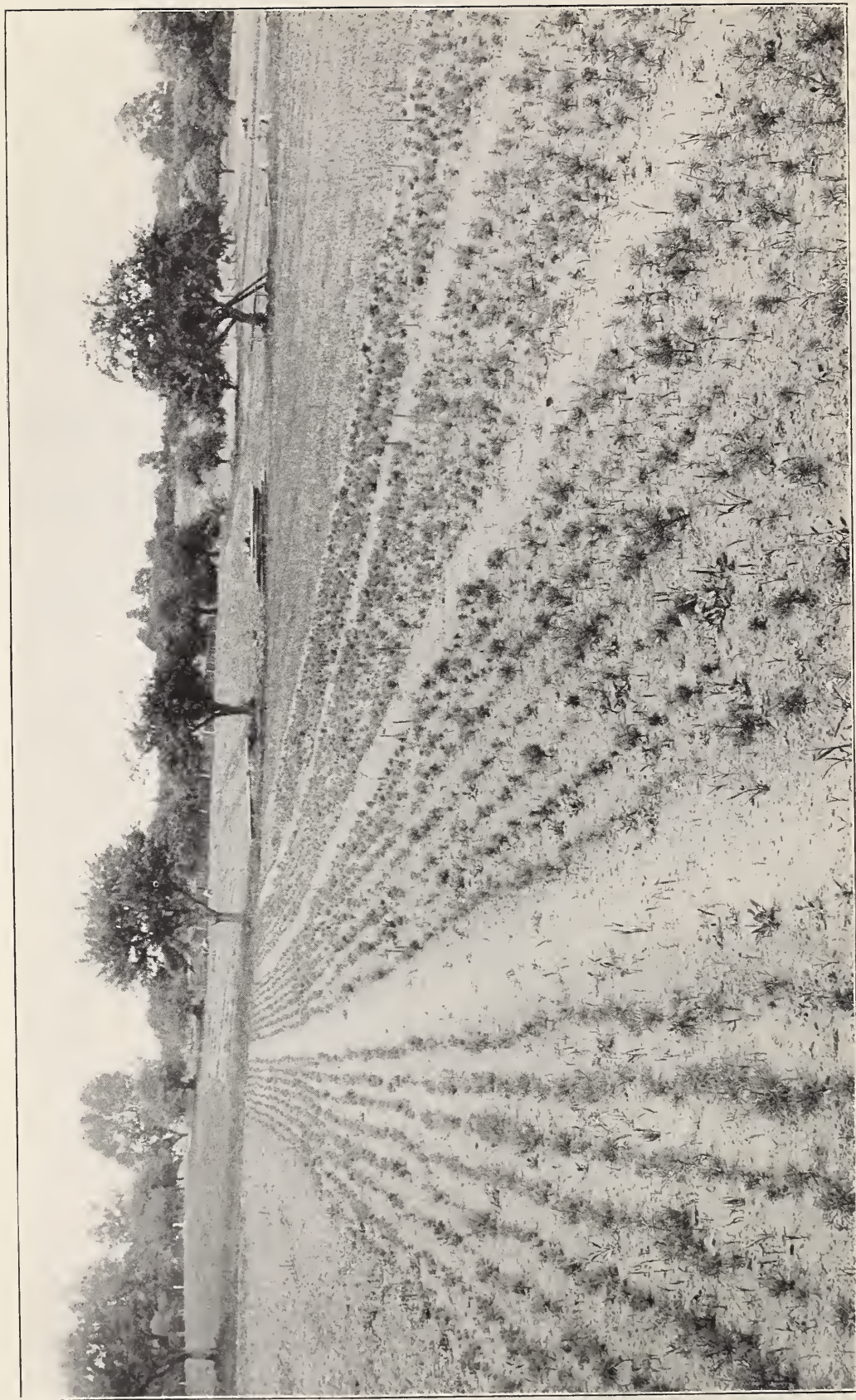
granted only to residents of Natick and of the village of Cochituate in Wayland, the towns in which the lake is situated, and the owners or licensees of cottages whose ownership or leasehold interest was prior to March 1, 1906.

Applications for registration of boats were received to the number of 172, and of these, 152 registrations were granted. Of those whose applications were granted 118 were residents of Natick, 14 residents of Cochituate and 20 owners or licensees of cottages. The boats for which registration was granted included 13 motor boats, 3 sail boats, 66 row boats and 70 canoes. Twenty-one applications were rejected for reasons that the applicants were residents of towns not situated on the lake, or not possessed of cottages prior to March 1, 1906, or because applications were for motor or sail boats not previously registered, or because registration had been granted to other members of the same family. Permission was given for 3 tenders to be used only in connection with the sail and motor boats. No request for registration, except in one instance where the application was made after the time of filing applications had expired, was refused to residents of the territory immediately surrounding the lake or to those who were owners or licensees of the adjacent cottages prior to March 1, 1906. There were, in addition, 218 licenses granted under the regulations for the use of boats in connection with the owners. The registrations of 4 boats were revoked because the owners violated the conditions under which the licenses were issued by permitting the boats to be used in charge of unlicensed persons.

The Board has maintained a motor boat, which has been of great service in patrolling the lake and in seeing that the regulations adopted by the Board were complied with, as well as generally protecting the lake from pollution. Careful inspection and patrolling have been provided as well upon the shores. All owners of cottages on land surrounding the lake were strictly required to keep the premises abutting the shore margins in good sanitary condition.

During the year 8 new cottages were built on the adjacent land, while 1 was burned and 2 joined together, so that the number located around the lake at the end of the year was 65.

The Board was forced to adopt restrictions upon the use of the lake by the public on account of the rapid increase of boating, its use for boat races, the building of club houses, the occupancy of the



FORESTRY AT WACHUSETT RESERVOIR - THREE-YEAR-OLD PINES IN NURSERY

nearer lands for camping and the attempted sale of lands near the lake for picnic resorts and the sale of small lots for summer cottages, causing a permanent menace to the purity of the waters for a water supply. It had sought, so far as it seemed possible or practicable, to permit those who had before naturally used the lake for boating to continue such use under inspection and strict regulations for the prevention of pollution. The Board could have deprived the people of the towns and the summer cottagers of the practical enjoyment of the lake by prohibiting them from crossing the marginal lands belonging to the Commonwealth, but no such restrictive action has ever been taken. It has not only sought to prevent the vicinity of the lake from becoming a summer and picnic resort, but has been making constant improvements in the sanitary conditions of the surroundings of the lake and the various streams which flow into it. So far it is believed by the Board that its waters have been kept from such condition as would injure their use for the purposes of a water supply.

Considerable improvements are, however, contemplated to be made in order to ensure the waters against any objectionable condition in the future.

Boating, however, upon reservoirs from which the water is drawn more or less directly for a water supply is generally recognized as undesirable and among the menaces which threaten the purity of the water, and it is not permitted in a considerable proportion of other large systems of water supply.

Notwithstanding all the means provided for rendering boating on Lake Cochituate as little harmful as possible, it becomes more and more doubtful to the Board, from its experience and from the advice which is given it, whether it can continue to permit, on a reservoir so directly furnishing a water supply, a practice which is pronounced to be hazardous to the health of the people of the Metropolitan District.

(9) FORESTRY.

An area of 212 acres of land around the Wachusett Reservoir was planted during the year, there being used for this planting 253,610 white pines, 2,080 Norway spruces and 8,285 locusts. Owing to the greater distance of these areas from the nurseries, and the larger proportion of swamp and sprout land, which is not so favor-

able for planting, the cost was somewhat larger than in previous years, the cost of removing trees from the nurseries and planting them having averaged \$5.50 per thousand trees, or \$6.40 per acre. It is found that the circumstances are more favorable to the growth of pines than other trees, so that a much larger proportion of pines are now planted.

Considerable work has been done in the cutting out of undesirable and mature trees and brush, in order that the growth of the young pines may not be interfered with.

The brush and weeds on the 40-foot marginal fire guard and on the various forest roads have been mowed and burned.

The Flag nursery, on the south side of the reservoir, now contains 64,200 white pines and 28,300 arbor vitæ. In the Lamson nursery, on the north side of the reservoir, there are 154,200 arbor vitæ, 4,000 sugar maples, 2,800 ashes, 2,600 locusts, 2,170 white oaks, 1,150 walnuts and 54 catalpas. The transplanting of the maples, oaks and walnuts has not been found successful.

Of the 3,380 acres of land belonging to the Commonwealth around the reservoir, 1,475 acres were forested when acquired, but of these, 209 acres have since been improved. Trees have been planted upon 1,330 acres, of which 488 were also cleared. There is an area of 39 acres which it is still proposed to plant. The open area comprises 536 acres, of which 197 acres are embraced in the marginal strip along the shores of the reservoir.

About 4,300 pine trees have been planted on the lands around the Sudbury Reservoir and a few maples have been placed along the road leading to the Sudbury Dam. Some pine trees have been planted at the Weston Reservoir and at points along the Weston Aqueduct.

(10) MOTH SUPPRESSION AND TREE PROTECTION.

The work done under the direction of the Board has during the past year been directed not only to the destruction of the gypsy and brown-tail moths but also to the protection of the trees from the ravages of the elm-leaf beetles and the pine-tree weevils.

Owing undoubtedly to the efforts of the past few years, the number of the gypsy moths has decreased. They are still found, however, in large numbers about Spot Pond and along the line of the



FORESTRY AT WACHUSETT RESERVOIR — NINE-YEAR-OLD PINES PLANTED IN PASTURE LAND.

Cochituate, Sudbury and Weston aqueducts, particularly in Newton and Weston. Considerable numbers were also found about Lake Cochituate, more generally in the vicinity of the summer camps. The gypsy moths have for the first time been discovered about Framingham reservoirs Nos. 2 and 3 and about the Whitehall Reservoir in Hopkinton, but they have not yet infested the Wachusett watershed.

The brown-tail moths have increased in comparison with the previous year. They have been found not only at Spot Pond and around the Sudbury Reservoir, but also in increasing numbers in the vicinity of the Wachusett Dam and even at the upper end of the Wachusett Reservoir in West Boylston.

The methods followed for the suppression of moths have been the same as in previous years, painting the egg clusters of the gypsy moths with a mixture of creosote and fuel oil, cutting off and burning the nests of the brown-tail moths, banding the trees with tanglefoot early in the spring to prevent the caterpillars from ascending the trees, spraying with arsenate of lead all trees which are found to be infested with moths, banding with burlap the trees in places where moths are known or suspected to be present, and destroying the full-grown caterpillars which have collected under the burlap.

The elm-leaf beetles have been discovered in increasing numbers, attacking the large elm trees, especially in the vicinity of Southborough. Trees infested with elm-leaf beetles were sprayed with arsenate of lead, and the trunks were scraped from the ground to a height of eight or ten feet.

The young pine trees on lands around the Wachusett and Sudbury reservoirs, of which about 1,000,000 have been planted during the past six years, were in the middle of the summer found to be infested with the pine-tree weevil, which cuts off the young shoots, generally the leader at the top of the tree. The weevils were destroyed by cutting off and burning the affected shoots.

(11) QUALITY OF THE WATER.

The examinations of the water supplied to the Metropolitan District during the past year, made both in the laboratory of the Board and by the State Board of Health, indicate an improvement in the quality of the water in almost every respect, and the results of these examinations show that the water supplied has been better than for

many years previous. The number of organisms has somewhat increased, but they have not generally been of an objectionable character. Those found in Lake Cochituate did afford a disagreeable odor and taste, although not unwholesome, and during the larger portion of the year the water from the lake was not supplied to the District. The water in the various distributing reservoirs has been generally free from the objectionable organisms.

(12) THE WATER SUPPLY.

The rainfall on all the watersheds and the consequent yield of water has for the fifth consecutive year been below the average recorded for years during which records have been kept. The rainfall on the Sudbury watershed was 36.15 inches, which is 9.55 inches below the average for thirty-four years, and the lowest of record except in the year 1883, which was known as the "dry year." The rainfall on the Wachusett watershed was 37.83 inches, which is 10.23 inches below the average of the past twelve years recorded. During the last seven months the yield has been especially small.

The city of Newton and the town of Hyde Park have obtained their supply of water from their own sources, which so far have proved adequate for their uses, but all the other cities and towns constituting the Metropolitan District have been supplied with water, and, in addition, under special arrangements, the town of Swampscott, a small portion of the town of Saugus and the United States Government reservation on Peddock's Island.

The average daily quantity of water furnished, as determined by measurement at the pumping stations and by the flow through the Weston Aqueduct, including the estimated yield of Spot Pond, was 127,301,000 gallons, which is an increase in the daily supply of 2,230,000 gallons over the preceding year.

V. WATER WORKS—FINANCIAL STATEMENT.

The financial abstract of the receipts, disbursements, assets and liabilities of the Board for the State fiscal year, beginning with December 1, 1907, and ending with November 30, 1908, was, in accordance with the requirements of chapter 255 of the Acts of the year 1906, presented to the General Court in January last, and a copy of this financial abstract is printed as Appendix No. 5.

The more detailed statement of its doings required by said chapter, for the calendar year 1908, in relation to the Metropolitan Water Works, is herewith presented.

The Metropolitan Water Loans authorized for the construction and acquisition of works have amounted to \$40,898,000. To this sum are added the proceeds from the sale of certain property by the Board, and these amounted on January 1, 1909, to \$162,566.87. The total amount, therefore, which the Board has been authorized to expend is \$41,060,566.87. The amount of expenditures approved by the Board for payment out of the Metropolitan Water Loan Fund was, for the year 1908, \$217,129.47, and the total amount so approved for payment since the beginning of the work up to January 1, 1909, has been \$40,684,637.51. There was accordingly a balance remaining at the beginning of the year 1909 amounting to \$375,929.36.

The Treasurer of the Commonwealth has issued from time to time, on the request of the Board, bonds to the amount of \$40,500,000. These bonds were issued for terms of thirty-nine and one-half and forty years from the date of issue, and bear interest at the rate of 3 per cent. and $3\frac{1}{2}$ per cent. per annum. The sinking fund established for the payment of the bonds at maturity amounted on January 1, 1909, to \$6,419,283.28.

The amount approved by the Board for the maintenance and operation of the Water Works for the year 1908, which was paid out of the annual assessments, was \$389,584.54.

The assessments for the year 1908, for the payment of interest on the bonds, for the sinking fund requirements, and for the expenses of operation and maintenance of the Water Works, which were levied upon the various cities and towns in the Metropolitan District, amounted to \$2,271,151.53.

The detailed financial statement regarding the Metropolitan Water Works is as follows:—

(1) METROPOLITAN WATER LOANS, RECEIPTS AND PAYMENTS.

The loans authorized for the construction and acquisition of the Metropolitan Water Works, the receipts which are added to the proceeds of these loans, the expenditures for the construction and acquisition of works, and the balance available on January 1, 1909, have been as follows:—

Loan under chapter 488 of the Acts of 1895,	\$27,000,000 00
Loan under chapter 453 of the Acts of 1901,	13,000,000 00
Loan under chapter 367 of the Acts of 1906,	500,000 00
Loan under chapter 558 of the Acts of 1908,	398,000 00

\$40,898,000 00

Proceeds from the sales of property applicable to the construction and acquisition of works (of which \$4,158.76 is for the year 1908),	162,566 87
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\$41,060,566 87

Amount approved by the Metropolitan Water and Sewerage Board for payments to December 31, 1908 (of which \$217,-129.47 is for the year 1908),	40,684,637 51
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Balance January 1, 1909,

\$375,929 36

(2) ISSUES OF METROPOLITAN WATER LOAN BONDS.

The Treasurer of the Commonwealth, under the authority given him to issue from time to time, on the request of the Board, negotiable bonds to an amount not exceeding \$40,898,000, to be designated the "Metropolitan Water Loan," has sold bonds as follows:—

DATE OF SALE.	Amount of Bonds sold.	Rate of Interest (Per Cent.).	Price received.	Date due.	Premium.
Sept. 25, 1895,	\$5,000,000	3½	110.67	July 1, 1935,	\$533,500 00
Nov. 23, 1896,	2,000,000	3½	106.76268	July 1, 1935,	135,253 60 ¹
Feb. 8, 1897,	6,000,000	3½	107.82	July 1, 1935,	469,200 00
Jan. 13, 1898,	2,000,000	3½	113.176	Jan. 1, 1938,	263,520 00
Mar. 2, 1898,	2,000,000	3½	112.877	Jan. 1, 1938,	257,540 00
June 15, 1899,	3,000,000	3	100.64	July 1, 1939,	19,200 00
June 28, 1900,	1,000,000	3	102.78	July 1, 1939,	27,800 00
Mar. 5, 1901,	3,000,000	3	102.155	Jan. 1, 1941,	64,650 00
July 24, 1901,	100,000	3	100.375	Jan. 1, 1941,	375 00
July 24, 1901,	150,000	3	100.10	Jan. 1, 1941,	150 00
July 30, 1901,	205,000	3	100.25	Jan. 1, 1941,	512 50
July 31, 1901,	50,000	3	100.25	Jan. 1, 1941,	125 00
Aug. 7, 1901,	50,000	3	100.50	Jan. 1, 1941,	250 00
Aug. 8, 1901,	300,000	3	100.10	Jan. 1, 1941,	300 00
Aug. 8, 1901,	200,000	3	100.25	Jan. 1, 1941,	500 00
Sept. 17, 1901,	3,100,000	3½	106.71	Jan. 1, 1941,	208,010 00
Oct. 1, 1901,	1,345,000	3	100.	Jan. 1, 1941,	—
Oct. 24, 1901,	1,500,000	3	100.	Jan. 1, 1941,	—
Feb. 26, 1902,	500,000	3½	109.13	Jan. 1, 1942,	45,650 00
Feb. 26, 1902,	3,000,000	3½	109.13	Jan. 1, 1942,	273,900 00
April 7, 1903,	250,000	3½	106.725	Jan. 1, 1943,	16,812 50
April 17, 1903,	1,250,000	3½	106.1329	Jan. 1, 1943,	76,661 25
Jan. 15, 1904,	500,000	3½	104.60	Jan. 1, 1943,	23,000 00
Jan. 15, 1904,	2,000,000	3½	104.60	Jan. 1, 1944,	92,000 00
Mar. 24, 1905,	650,000	3½	105.761	Jan. 1, 1945,	37,446 50
June 28, 1906,	943,000	3½	103.09	Jan. 1, 1946,	29,138 70
June 28, 1906,	100,000	3½	103.09 ²	Jan. 1, 1946,	3,090 00
June 28, 1906,	307,000	3½	103.09 ²	Jan. 1, 1946,	9,486 30
	\$40,500,000				\$2,588,071 35

¹ Including \$18,673.60 from readjustment of rate made by the Treasurer in 1897.

² Not issued or delivered until 1907.

Prior to May 1, 1906, all premiums received from the sales of bonds were applied to the payment of the current charges in reduction of the annual assessments, but since that date, under the provisions of chapter 337, Acts of 1906, they have been paid into the sinking fund.

(3) METROPOLITAN WATER LOAN SINKING FUND.

The sinking fund established by the Treasurer of the Commonwealth has amounted at the end of each year to sums as follows:—

December 31, 1895,	.	.	.	.	.	.	.	\$226,286 05
December 31, 1896,	.	.	.	.	.	.	.	699,860 70
December 31, 1897,	.	.	.	.	.	.	.	954,469 00
December 31, 1898,	.	.	.	.	.	.	.	1,416,374 29
December 31, 1899,	.	.	.	.	.	.	.	1,349,332 97
December 31, 1900,	.	.	.	.	.	.	.	1,573,619 72
December 31, 1901,	.	.	.	.	.	.	.	1,662,426 95
December 31, 1902,	.	.	.	.	.	.	.	2,256,803 81
December 31, 1903,	.	.	.	.	.	.	.	2,877,835 59
December 31, 1904,	.	.	.	.	.	.	.	3,519,602 92
December 31, 1905,	.	.	.	.	.	.	.	4,207,045 69
December 31, 1906,	.	.	.	.	.	.	.	4,897,822 62
December 31, 1907,	.	.	.	.	.	.	.	5,643,575 69
December 31, 1908,	.	.	.	.	.	.	.	6,419,283 28

(4) ANNUAL ASSESSMENTS AND RECEIPTS.

Assessments for the year, amounting to \$2,271,151.53, were required for the payment of the interest on the bonds issued by the Commonwealth, the sinking fund requirements, and the expenses of operation and maintenance of the Water Works. The requirements were: for interest, \$1,433,517.91; for the sinking fund, \$519,581.23; and for maintenance and operation, \$318,052.39. These assessments were made by the Treasurer of the Commonwealth upon the various municipalities as follows:—

Arlington,	.	.	.	\$16,552 50	Everett,	.	.	.	\$42,428 56
Belmont,	.	.	.	6,832 38	Hyde Park,	.	.	.	1,261 26
Boston,	.	.	.	1,789,315 84	Lexington,	.	.	.	6,845 05
Chelsea,	.	.	.	58,288 06	Malden,	.	.	.	38,049 53

Medford, . . .	\$36,955 49	Somerville, . . .	\$108,691 08
Melrose, . . .	28,693 90	Stoneham, . . .	9,727 88
Milton, . . .	14,713 89	Watertown, . . .	15,639 86
Nahant, . . .	4,282 55	Winthrop, . . .	15,486 79
Newton, . . .	6,259 58		
Quincy, . . .	49,285 01		\$2,271,151 53
Revere, . . .	21,842 32		

The comparatively smaller sums assessed upon the city of Newton and the town of Hyde Park were owing to the fact that neither of these municipalities had reached the safe capacity of its own sources of water supply, and neither had been furnished with water.

The proceeds from the operations of the Board, exclusive of the proceeds from sales of property and of water, are required by statute to be applied to the payment of the interest, the sinking fund requirements and expenses of maintenance and operation of works. These for the year 1908 amounted to \$6,361.93.

The amount approved by the Board for the maintenance and operation of the Metropolitan Water Works was, for the year 1908, \$389,584.54.

(5) SUPPLYING WATER TO CITIES AND TOWNS OUTSIDE OF DISTRICT AND TO WATER COMPANIES.

Sums have been received during the year 1908, under the provisions of the Metropolitan Water Act, for water furnished, as follows:—

Town of Framingham,	\$429 39
Town of Swampscott,	4,800 00
Town of Revere,	550 00
United States Government,	1,615 22
	<hr/>
	\$7,394 61

The sums so received, prior to March 23, 1907, were annually distributed among the cities and towns of the District, but since that date, in accordance with the provisions of chapter 238 of the Acts of 1907, the sums so received have been paid into the sinking fund.

(6) EXPENDITURES FOR THE DIFFERENT WORKS.

The following is a summary of the expenditures made in the various operations for the different works:—

CONSTRUCTION AND ACQUISITION OF WORKS.	For the Year ending December 31, 1908.	From Beginning of Work to December 31, 1908.
Administration applicable to all parts of the construction and acquisition of the works,	\$5,219 14	\$274,187 56
Wachusett Dam and Reservoir: —		
Wachusett Dam,	\$91,910 04	\$2,377,009 24
Power plant,	—	118 00
North Dike,	1,495 00	791,965 68
South Dike,	17 45	137,074 55
Removal of soil,	301 78	2,536,516 15
Relocation of railroads,	3,825 00	881,847 45
Roads and bridges,	240 45	547,420 78
Real estate,	9,263 31	3,205,214 04
Damages, real estate not taken, business and loss of wages,	9,253 33	527,997 07
Other expenses,	275 00	8,547 92
	116,581 36	11,013,710 88
Improving Wachusett watershed,	4,430 54	211,837 07
Wachusett Aqueduct,	—	1,797,946 85
Sudbury Reservoir,	688 50	2,923,133 71
Protection of Sudbury supply,	—	129,190 36
Improving Sudbury watershed,	5 30	95,489 84
Protection of Cochituate supply,	—	9,000 00
Improving Cochituate watershed,	—	8,860 68
Improving Lake Cochituate,	600 00	104,137 29
Pipe lines, Dam No. 3 to Dam No. 1,	—	48,471 48
Pipe line, Rosemary siphon,	—	23,142 98
Weston Aqueduct: —		
Aqueduct,	\$8 10	\$2,352,192 76
Reservoir,	163 76	289,001 82
Supply pipe lines,	163 40	584,803 11
Real estate, taxes and other expenses,	14,283 39	221,926 51
	14,618 65	3,447,924 20
Distribution system: —		
Low service: —		
New 48-inch main, Section 31,	\$64,569 27	\$64,569 27
Pipe lines and connections,	18 92	1,752,892 00
Pumping station, Chestnut Hill,	—	462,572 19
Reservoir, Spot Pond,	—	582,188 73
Gate house and connections, Chestnut Hill Reservoir,	—	65,480 88
Real estate and other expenses,	3 50	91,725 56
Amounts carried forward,	\$64,591 69 \$142,143 49	\$3,019,428 63 \$20,087,032 90

CONSTRUCTION AND ACQUISITION OF WORKS.	For the Year ending December 31, 1908.	From Beginning of Work to December 31, 1908.
<i>Amounts brought forward,</i>	\$64,591 69 \$142,143 49	\$3,019,428 63 \$20,087,032 90
Distribution system — <i>Concluded.</i>		
Northern high service: —		
Pipe lines and connections,	34 48	440,575 26
Spot Pond pumping station,	—	291,829 35
Fells Reservoir, Stoneham,	—	141,392 94
Bear Hill Reservoir, Stoneham,	—	38,267 70
Real estate and other expenses,	—	14,838 05
Southern high service: —		
Pipe lines and connections,	677 75	515,810 05
Pumping station, Chestnut Hill,	152 53	247,081 49
Forbes Hill Reservoir, Quincy,	—	90,003 49
Waban Hill Reservoir, Newton,	—	61,592 11
Real estate and other expenses,	—	10,226 36
Northern extra high service,	10,688 31	82,717 44
Southern extra high service,	—	22,830 67
Meters and connections,	1,532 23	78,570 56
Improving Spot Pond Brook,	—	3,991 23
Glenwood pipe yard,	—	33,100 59
Chestnut Hill pipe yard,	—	11,311 26
	77,676 99	5,103,567 18
Diversion of water, South Branch of Nashua River, ¹	52 55	1,363,684 31
Acquisition of existing water works: —		
Reimbursement city of Boston, partially con- structed Sudbury Reservoir,	—	\$1,157,921 59
To Boston, for works taken January 1, 1898, To Malden, Medford and Melrose for taking of Spot Pond,	—	12,768,948 80
To Newton, for Waban Hill Reservoir,	—	1,240,229 62
	—	60,000 00
Transfers of works acquired and other prop- erty to accounts for special works,	—	\$15,227,100 01
		1,240,262 50
		\$13,986,837 51
Engineering, conveyancing, etc.,	\$2 25	73,128 47
	2 25	14,059,965 98
<i>Pipes, Valves, Castings, etc., sent first to Storage Yards, and afterwards transferred as needed to Different Parts of the Work.</i>	\$219,875 28	
Sent to storage yards,	\$966 85	\$2,093,362 91
Transferred from storage yards to works, and included in costs above,	3,712 66	2,022,975 77
		70,387 14
Deduct excess of transfers over amount purchased during year 1908,	2,745 81	
Total for constructing and acquiring of works,	\$217,129 47	\$40,684,637 51

¹ Of the total expenditures from the beginning of the work, the sum of \$150,938.89 is for Clinton sewerage system.

MAINTENANCE AND OPERATION.	For the Year ending December 31, 1908.	
Administration,	\$13,247	35
General supervision,	29,395	92
Taxes and other expenses,	35,714	97
Wachusett Reservoir Department: —		
Superintendence,	\$6,061	04
Reservoir,	14,081	46
Forestry,	7,453	94
Protection of supply,	2,560	06
Buildings and grounds,	3,042	23
Wachusett dam,	6,962	32
Wachusett aqueduct,	3,251	46
Clinton sewerage system: —		
Pumping station,	3,394	64
Sewers, screens and filter-beds,	6,826	43
Sanitary inspection,	1,642	09
Swamp drainage,	2,138	05
57,413		72
Sudbury Department: —		
Superintendence, Framingham office,	\$7,604	05
Ashland Reservoir,	1,633	79
Hopkinton Reservoir,	2,078	54
Whitehall Reservoir,	836	43
Framingham Reservoirs, 1, 2 and 3,	5,753	49
Sudbury Reservoir,	8,720	26
Lake Cochituate,	6,222	49
Marlborough Brook filters,	2,389	09
Pegan filters,	2,628	51
Sudbury and Cochituate watersheds,	922	10
Sanitary inspection,	3,005	84
Cochituate Aqueduct,	5,811	35
Sudbury Aqueduct,	12,194	80
Weston Aqueduct,	4,684	89
64,485		63
Distribution Department: —		
Superintendence,	\$4,844	56
Arlington Pumping station, pumping service,	9,238	43
Chestnut Hill low-service pumping station, pumping service,	35,080	60
Chestnut Hill high-service pumping station, pumping service,	52,437	73
Spot Pond pumping station, pumping service,	16,117	14
West Roxbury pumping station, pumping service,	7,393	20
Arlington standpipe,	364	13
Bear Hill Reservoir,	249	40
Chestnut Hill Reservoir,	10,468	00
Fells Reservoir,	385	68
Forbes Hill Reservoir,	1,045	11
Mystic Lake, conduit and pumping station,	3,953	98
Mystic Reservoir,	1,248	95
Waban Hill Reservoir,	442	32
Weston Reservoir,	2,166	94
<i>Amounts carried forward,</i>		\$145,436 17 \$200,257 59

MAINTENANCE AND OPERATION.	For the Year ending December 31, 1908.	
<i>Amounts brought forward,</i>	\$145,436 17	\$200,257 59
<i>Distribution Department — Concluded.</i>		
Spot Pond,	7,722 59	
Buildings at Spot Pond,	145 02	
Pipe lines: —		
Low service,	7,814 43	
Northern high service,	2,756 37	
Southern high service,	6,223 58	
Supply pipe lines,	385 08	
Buildings at Chestnut Hill,	1,775 62	
Chestnut Hill pipe yard,	1,642 86	
Glenwood pipe yard and buildings,	3,995 56	
Stables,	7,377 63	
Waste prevention,	119 42	
Venturi meters,	1,240 03	
Measurement of water,	1,068 36	
Arlington pumping station, buildings and grounds,	1,624 23	
	189,326 95	
Total for maintaining and operating works,	\$389,584 54	

(7) DETAILED FINANCIAL STATEMENT UNDER METROPOLITAN WATER ACT.

The Board herewith presents, in accordance with the requirements of the Metropolitan Water Act, a detailed statement of the expenditures and disbursements, receipts, assets and liabilities for the year 1908.

(a) *Expenditures and Disbursements.*

The total amount of the expenditures and disbursements on account of construction and acquisition of works for the year beginning January 1, 1908, and ending December 31, 1908, is \$217,129.47, and the total amount from the time of the organization of the Metropolitan Water Board, July 19, 1895, to December 31, 1908, is \$40,684,637.51.

For maintenance and operation the expenditures for the year have been \$389,584.54, and from the beginning of the work, \$3,413,880.85.

The salaries of the commissioners, and other expenses of administration, have been apportioned to the construction of the works and to the maintenance and operation of the same, and appear under each of those headings.

The following is a division of the expenditures according to their general character: —

GENERAL CHARACTER OF EXPENDITURES.	For the Year ending December 31, 1908.	From Beginning of Work to December 31, 1908.
CONSTRUCTION OF WORKS AND ACQUISITION BY PURCHASE OR TAKING.		
<i>Administration.</i>		
Commissioners,	\$2,333 23	\$114,976 91
Secretary and auditor,	750 00	49,092 03
Clerks and stenographers,	1,735 00	59,184 16
Legal services,	—	2,359 00
Travelling,	—	3,640 89
Stationery and printing,	28 20	11,223 96
Postage, express and telegrams,	—	2,807 17
Furniture and fixtures,	—	4,280 89
Alterations and repairs of buildings,	—	5,784 27
Telephone, lighting, heating, water and care of building,	271 53	11,402 37
Rent and taxes, main office,	83 33	4,940 34
Miscellaneous expenses,	17 75	4,495 57
	\$5,219 14	\$274,187 56
<i>Engineering.</i>		
Chief engineer and department engineers,	\$300 00	\$207,471 36
Principal assistant engineers,	1,609 62	157,213 51
Engineering assistants,	8,559 72	1,032,025 69
Consulting engineers,	825 00	24,415 07
Inspectors,	664 74	290,882 13
Architects,	—	36,161 19
Railroad and street car travel,	12 35	26,817 26
Wagon hire,	269 00	45,297 78
Stationery and printing,	140 52	26,136 29
Postage, express and telegrams,	5 35	7,729 18
Engineering and drafting instruments and tools,	—	19,308 03
Engineering and drafting supplies,	30	24,962 01
Books, maps and photographic supplies,	36 74	6,968 46
Furniture and fixtures,	—	14,978 46
Alterations and repairs of buildings: —		
Main office,	—	14,107 86
Sub-offices,	—	2,939 36
Telephone, lighting, heating, water and care of buildings: —		
Main office,	796 58	24,873 39
Sub-offices,	2 80	19,625 12
Rent and taxes, main office,	250 00	14,589 45
Rent of sub-offices and other buildings,	—	4,526 74
Field offices and sheds,	—	1,274 49
Clinton office building,	—	9,866 87
Unclassified supplies,	—	8,240 53
Miscellaneous expenses,	1 95	8,926 27
	13,474 67	2,029,336 50
<i>Amounts carried forward,</i>	\$18,693 81	\$2,303,524 06

GENERAL CHARACTER OF EXPENDITURES.	For the Year ending December 31, 1908.	From Beginning of Work to December 31, 1908.
<i>Amounts brought forward,</i>	\$18,693 81	\$2,303,524 06
<i>Construction.</i>		
Preliminary work (borings, test pits and other investigations): —		
Advertising,	\$36 58	\$6,342 80
Other preliminary work as given in detail in preceding annual report,	—	155,457 41
	36 58	161,800 21
Contracts, Wachusett Reservoir: —		
Contracts completed and final payments made prior to January 1, 1908, . . .	—	\$5,314,738 30
McBride & Co., Stillwater improvement, . .	—	23,314 67
Sundry bills paid under this contract, . .	—	3,476 60
McArthur Bros. Co., in settlement of claim under item 26 of Contract 195,	\$88,200 00	88,200 00
McArthur Bros. Co., in settlement of claim on account of building Sect. 2 of the relocation of Central Massachusetts Railroad, Contract 195A,	3,800 00	3,800 00
	92,000 00	5,433,529 57
Contracts completed, improving Wachusett Watershed: —		
Sterling filter-beds,	—	11,893 75
Contracts completed, Wachusett Aqueduct, .	—	1,447,208 55
Contracts completed, Sudbury Reservoir, .	—	1,545,028 33
Contracts completed, protection Sudbury Supply: —		
City of Marlborough, main sewer,	—	9,000 00
Contracts completed, improving Lake Cochituate,	—	60,657 45
Contracts completed, protection Cochituate Supply: —		
Town of Framingham, low-level sewer, . .	—	9,000 00
Contracts completed, Rosemary siphon, . .	—	5,916 96
Contracts completed, pipe line, Dam No. 3 to Dam No. 1,	—	17,240 22
Contracts completed, Clinton sewerage system, .	—	66,878 22
Contracts, Weston Aqueduct: —		
Contracts completed and final payments made prior to January 1, 1908,	—	\$1,781,564 31
Shanahan, Casparis & Co., Sect. 2,	—	201,827 74
Sundry bills paid under this contract, . .	—	2,911 80
Shanahan, Casparis & Co., Sect. 3,	—	126,420 70
Sundry bills paid under this contract, . .	—	4,214 78
Shanahan, Casparis & Co., Sect. 6,	—	108,933 26
Sundry bills paid under this contract, . .	—	7,013 05
Shanahan, Casparis & Co., Sect. 12,	—	138,151 78
Sundry bills paid under this contract, . .	—	3,339 77
		2,374,377 19
<i>Amounts carried forward,</i>	\$110,730 39	\$13,446,054 51

GENERAL CHARACTER OF EXPENDITURES.	For the Year ending December 31, 1908.	From Beginning of Work to December 31, 1908.
<i>Amounts brought forward,</i> . . . .	. . . \$110,730 39	\$13,446,054 51
<i>Construction — Con.</i>		
Contracts, Distribution System: —		
Contracts completed and final payments made prior to January 1, 1908,	—	\$4,423,966 12
The Blake & Knowles Steam Pump Works, for furnishing and erecting pumping engine at Arlington pumping station,	\$5,240 00	5,240 00
Coffin Valve Co., for water valves for new 48-inch main, Section 31,	1,370 20	1,370 20
Bruno & Petitti, for laying water pipes for new 48-inch main, Section 31,	9,239 70	9,239 70
Warren Foundry and Machine Co., for fur- nishing cast-iron pipes and special castings for new 48-inch main, Section 31,	43,296 96	43,296 96
Allis-Chalmers Co., pumping engine,	458 00	4,895 00
	59,604 86	
Deduct value of pipes, valves, etc., included in above list, transferred to maintenance account December 31, 1900,	—	\$4,488,007 98 3,139 77
		4,484,868 21
Additional work: —		
Labor,	\$5,557 45	\$757,744 34
Professional services, medical services, analy- ses, etc.,	50 00	1,907 99
Travelling,	20	2,744 20
Rent,	—	3,611 73
Water rates,	—	1,454 77
Freight and express,	75 14	13,019 65
Jobbing and repairing,	18 05	9,686 13
Tools, machinery, appliances, and hardware supplies,	3,471 11	77,413 88
Electrical supplies,	437 13	5,361 81
Castings, ironwork and metals,	2,634 08	82,047 79
Iron pipe and valves,	1,082 58	61,450 27
Blasting supplies,	1 20	1,936 88
Paint and coating,	37 08	4,353 51
Fuel, oil and waste,	2 38	10,515 15
Lumber and field buildings,	749 22	86,037 14
Drain pipe,	13 43	9,163 80
Brick, cement and stone,	111 00	26,499 79
Sand, gravel and filling,	7 10	6,902 16
Municipal and corporation work,	119 53	209,007 43
Police service,	—	210,801 74
Sanitary inspection,	7 00	13,107 09
Judgments and settlements for damages, . .	—	52,624 26
Unclassified supplies,	152 06	17,257 41
Miscellaneous expenses,	24 30	5,953 40
	14,550 04	1,670,602 32
<i>Amounts carried forward,</i> . . . .	. . . \$184,885 29	\$19,601,525 04

GENERAL CHARACTER OF EXPENDITURES.	For the Year ending December 31, 1908.	From Beginning of Work to December 31, 1908.
<i>Amounts brought forward,</i>	\$184,885 29	\$19,601,525 04
<i>Construction — Con.</i>		
Legal and expert: —		
Legal services,	-	\$4,668 82
Expert services,	-	1,862 66
Court expenses,	\$150 00	1,317 20
Miscellaneous expenses,	-	185 80
	150 00	8,034 48
<i>Real Estate.</i>		
Legal and expert: —		
Legal services,	-	\$4,736 31
Conveyancer and assistants,	\$731 00	110,042 97
Experts,	-	17,871 58
Appraisers,	-	22,332 75
Court expenses,	-	11,139 43
Counsel expenses,	-	43 25
Conveyancing supplies,	16 00	3,181 53
Conveyancing expenses,	27 65	5,937 54
Miscellaneous expenses,	130 34	4,326 15
Settlements made by Board,	16,685 00	3,387,872 84
Judgments,	1,763 39	170,445 63
Taxes and tax equivalents,	-	68,182 41
Care and disposal,	2,125 97	86,866 06
	21,479 35	3,892,978 45
<i>Damages to Real Estate not taken, to Business and on Account of Loss of Wages.</i>		
Legal and expert: —		
Legal services,	-	\$1,130 67
Expert services,	-	2,857 62
Court expenses,	\$1,236 50	15,394 34
Miscellaneous expenses,	125 00	125 00
Settlements,	483 33	414,813 65
Judgments,	8,770 00	113,183 42
	10,614 83	547,504 70
<i>Claims on Account of Diversion of Water.</i>		
Legal and expert: —		
Legal services,	-	\$3,774 98
Expert services,	-	19,339 69
Court expenses,	-	20,775 49
Miscellaneous expenses,	-	1,289 58
Settlements,	-	917,350 00
Judgments,	-	220,719 67
		1,183,249 41
<i>Purchase of Existing Water Works.</i>		
Legal and expert: —		
Legal services,	-	\$1,878 89
Expert services,	-	13,569 82
<i>Amounts carried forward,</i>	\$217,129 47	\$15,448 71 \$25,233,292 08

GENERAL CHARACTER OF EXPENDITURES.	For the Year ending December 31, 1908.	From Beginning of Work to December 31, 1908.
<i>Amounts brought forward,</i>	- \$217,129 47	\$15,448 71 \$25,233,292 08
<i>Purchase of Existing Water Works — Con.</i>		
Legal and expert — <i>Con.</i>		
Court expenses,	-	29,728 38
Miscellaneous expenses,	-	1,470 94
Settlements and judgments,	-	15,227,100 01
		15,273,748 04
<i>Relocation Central Massachusetts Railroad.</i>		
Settlements,	-	177,597 39
Total amount of construction expenditures,	\$217,129 47	\$40,684,637 51

GENERAL CHARACTER OF EXPENDITURES.	For the Year ending December 31, 1908.
MAINTENANCE AND OPERATION OF WORKS.	
Administration: —	
Commissioners,	\$4,666 67
Secretary and assistants,	4,286 33
Postage, printing, stationery and other supplies,	2,586 26
Travelling,	559 01
Telephone, heating, lighting and care of building,	357 28
Alterations and repairs of building,	21 22
Rent and taxes, office building,	689 73
Miscellaneous expenses,	80 85
	\$13,247 35
Supervision and general superintendence: —	
Chief engineer and assistants,	\$22,852 80
Postage, printing, stationery, office and laboratory supplies,	1,277 97
Telephone, heating, lighting and care of offices,	2,146 16
Travelling and incidental expenses,	553 73
Alterations and repairs of buildings,	79 25
Rent and taxes, main office,	2,069 25
Miscellaneous expenses,	416 76
	29,395 92
Pumping service: —	
Labor,	\$64,507 45
Fuel,	46,077 67
Oil, waste and packing,	1,886 15
Repairs and renewals,	4,950 07
Small supplies and expenses,	2,059 40
Rent, West Roxbury pumping station,	786 36
	120,267 10
<i>Amount carried forward,</i>	\$162,910 37

GENERAL CHARACTER OF EXPENDITURES.	For the Year ending December 31, 1908.
<i>Amount brought forward,</i>	\$162,910 37
MAINTENANCE AND OPERATION OF WORKS — <i>Con.</i>	
Superintendents and assistant superintendents,	\$6,189 88
Engineering assistants,	7,964 20
Sanitary inspectors,	4,008 00
Recording and scientific instruments and supplies,	442 75
Labor and teaming,	129,311 15
Tools, machinery and appliances,	1,039 70
Lumber and hardware supplies,	2,680 20
Jobbing and repairing,	665 60
Travelling,	3,444 80
Horses, vehicles and stable expenses,	9,160 23
Fuel, lighting and telephone,	5,042 70
Municipal and corporation work,	574 15
Alteration and repairs of building,	460 39
Unclassified supplies,	6,981 96
Miscellaneous expenses,	5,566 36
Conveyancer and assistants,	131 64
Taxes and tax equivalents,	35,483 33
Contracts and agreements,	6,880 03
Contracts for pipes, valves, etc., bought from construction work since January 1, 1908,	647 10
	226,674 17
Total expenditures for maintenance and operation,	\$389,584 54

(b) Receipts.

The total amount of receipts from the operations of the Board and from sales of property for the year beginning January 1, 1908, and ending December 31, 1908, is \$19,395.46; and the total amount from the time of the organization of the Metropolitan Water Board, July 19, 1895, to December 31, 1908, is \$543,832.34. The general character of these receipts is as follows: —

GENERAL CHARACTER OF RECEIPTS.	For the Year ending December 31, 1908.	From Beginning of Work to December 31, 1908.
For distribution back to District: —		
Fees for admission to District,	—	\$92,265 00
Water furnished to cities and towns outside of District,	—	90,454 77
Water furnished to water companies,	—	37,145 88
		\$219,865 65
<i>Amount carried forward,</i>	—	\$219,865 65

GENERAL CHARACTER OF RECEIPTS.	For the Year ending December 31, 1908.	From Beginning of Work to December 31, 1908.
<i>Amount brought forward,</i>	-	\$219,865 65
To the credit of the loan fund: —		
Real estate and buildings,	\$639 06	\$35,000 52
Tools, supplies and reimbursements,	3,519 70	127,566 35
	\$4,158 76	162,566 87
To the credit of the maintenance fund: —		
Tools, supplies and reimbursements,	\$1,480 16	\$1,480 16
	1,480 16	1,480 16
To the credit of the sinking fund: —		
Water furnished to cities and towns outside of District and to water companies,	\$7,394 61	\$14,551 04
Forfeiture for contracts awarded but not executed,	-	500 00
Rents,	1,307 00	91,328 99
Land products,	4,805 15	50,407 26
Unclassified receipts and interest,	249 78	3,132 37
	13,756 54	159,919 66
Total receipts,	\$19,395 46	\$543,832 34

The foregoing receipts have been credited to the various objects or works, as follows: —

SOURCES OF RECEIPTS.	For the Year ending December 31, 1908.	From Beginning of Work to December 31, 1908.
Admission into Metropolitan Water District (Quincy, Nahant, Arlington, Stoneham, Milton and Lexington),	-	\$92,265 00
Supplying water to cities and towns outside of Water District (Swampscott, Revere, Lex- ington, Wakefield, Cambridge, Framingham, and U. S. Government), and to water com- panies (Framingham, Milton and Revere),	\$7,394 61	142,151 69
	\$7,394 61	\$234,416 69
Construction and acquisition of works: —		
Administration,	\$59 28	\$169 39
Wachusett Dam,	75 00	6,759 48
Wachusett Reservoir,	895 25	135,009 03
Wachusett Aqueduct,	-	5,204 70
Weston Aqueduct,	125 00	5,137 63
Sudbury Reservoir and watershed,	60 00	7,795 42
Distribution system,	1,777 48	73,359 33
Diversion of water, Clinton sewerage system,	-	1,367 94
Purchase of existing water works,	474 55	18,044 08
	3,466 56	252,847 00
<i>Amounts carried forward,</i>	\$10,861 17	\$487,263 69

SOURCES OF RECEIPTS.	For the Year ending December 31, 1908.	From Beginning of Work to December 31, 1908.
<i>Amounts brought forward,</i>	\$10,861 17	\$487,263 69
Maintenance and operation of works: —		
Administration,	\$102 83	\$102 83
General supervision,	311 97	311 97
Wachusett Aqueduct,	262 85	4,379 66
Wachusett Reservoir,	4,234 52	23,288 35
Sudbury system,	1,790 68	13,603 65
Distribution system,	1,383 94	10,504 41
Clinton sewerage system,	447 50	4,377 78
	8,534 29	56,568 65
Total receipts,	\$19,395 46	\$543,832 34

(c) *Assets.*

The following is an abstract of the assets of the Water Works, a complete schedule of which is kept on file in the office of the Board: —

Office furniture, fixtures and supplies; engineering and scientific instruments and supplies; police supplies; horses, vehicles, field machinery, etc.; machinery, tools and other appliances and supplies; real estate connected with works not completed; completed works, including real estate and buildings connected therewith.

(d) *Liabilities.*

There are liabilities as follows: —

Due on monthly pay rolls, \$1,383 90

The amount has been agreed upon in the following case, but the deed has not yet passed: town of West Boylston, \$800.

On the claims of the following it is impossible to state the amounts due for land damages, water rights and claims for damages to established business, as no sums have been agreed upon and suits are now pending in court for the determination of most of them: —

Patrick Bradley, Thomas H. Burgess, Lucy A. Wood, Elwin I. Chace, Henry F. Keyes, James E. Welch, Bridget M. Joyce, Byron D. Allen, J. Frank Wood *et al.*, Asa Knight, Mary J. Fyfe, estate of William E. Fyfe, George M. Plummer, Edward F. Merriam,

estate of Charles H. Hastings, George R. Hastings, William H. Hastings, Everett and Oliver S. Kendall, Sanford C. Kendall, estate of William H. Vickery, James H. and Hannah S. Wood. Ase-nath M. Bartlett, estate of Charles I. Longley, estate of Daniel M. Marsh, Francis W. M. Goodale, George W. Shattuck, Nellie M. Kirby, Willis A. Fuller, Boston & Albany Railroad Company.

VI. METROPOLITAN SEWERAGE WORKS.

The North Metropolitan System provides for an area situated in the Mystic River valley and for the larger part of the Charles River valley which lies north of the Charles River, and embraces the cities of Cambridge, Chelsea, Everett, Malden, Medford, Melrose, Somerville and Woburn and parts of the city of Boston, and the towns of Arlington, Belmont, Revere, Stoneham, Wakefield, Winchester and Winthrop and part of the town of Lexington, — 9 cities and 8 towns. The district has an area of 90.50 square miles. It has an estimated population, as of December 31, 1908, based upon the census of 1905, of 499,940; and it is estimated that of this number 424,050, or 84.8 per cent., contribute sewage to the North Metropolitan System.

The South Metropolitan System provides for the areas situated in that part of the Charles River valley lying south of the Charles River, a small portion of the valley north of the Charles River, and also a portion of the Neponset River valley; and embraces the cities of Newton, Quincy and Waltham, portions of the city of Boston, and the towns of Brookline, Hyde Park, Milton, Watertown and part of the town of Dedham, — 4 cities and 5 towns. This district has an area of 100.87 square miles. It has an estimated population, as of December 31, 1908, of 340,490, of which number it is estimated that 201,595, or 59.2 per cent., contribute sewage to the South Metropolitan System.

(1) NORTH METROPOLITAN SEWERAGE SYSTEM — CONSTRUCTION.

Extension of Deer Island and East Boston Pumping Stations.

Owing to the necessity of providing additional sewerage pumping facilities for the North Metropolitan System, the Legislature of the year 1908, upon the recommendation of the Board, authorized the

enlargement of the Deer Island and East Boston pumping stations and the installation and equipment of additional plants in these stations. A sum not exceeding \$195,000 was appropriated for the Deer Island station, and a sum not exceeding \$250,000 for the East Boston station, these sums to be expended in the three years beginning with 1908.

(a) Deer Island Pumping Station Extension.

The Board proceeded at once in the enlargement of the Deer Island station. The foundations for the enlargement have been built by day labor, under the direction of the Chief Engineer of the Sewerage Works, and plans have been made for the superstructures which are to be built for the engine and coal houses. The engine house extension will be 50 feet long and 46 feet wide, and that of the coal house will be 103 feet long and 35 feet wide, both buildings to be constructed in harmony with the architectural lines of the present station. The granite wall of the highway in front of the station has been extended so as further to protect the road against the action of the tides. A contract has been made with the Allis-Chalmers Company of Milwaukee, Wisconsin, for furnishing at this station a pumping engine, with boilers and other appurtenances, of the capacity of 100,000,000 gallons, to be of a type similar to that of the engines already installed at the station. It is expected that the construction of the engine will require a period of about two years.

(b) East Boston Pumping Station Extension.

The great fire which destroyed a large portion of the city of Chelsea on April 12, 1908, extended across the Chelsea Creek, and the flames set fire to the East Boston pumping station, which is located on the East Boston side of the creek. The roof, windows and doors of the station and the coal house and wharf were destroyed, and most of the iron and steel girders and piping were twisted and made useless, and the engines and boilers were largely impaired and entirely put out of commission. Immediate action was necessarily taken to provide for the sewage which was forced through the station by the pumping engines, and the greatest possible expedition was necessary in order that the interruption of sewage disposal should not injuriously affect the health of portions of the District. By



EAST BOSTON PUMPING STATION AFTER FIRE OF APRIL 12, 1908 —
OUTSIDE AND INSIDE

the adjustment of gates and valves the undiluted sewage from the separate systems connected with the works and some sewage from the other more offensive connections were temporarily provided for and arrangements were made by which necessary overflows should be as little troublesome as possible.

By carrying on the work with all possible expedition both night and day, one of the engines was started in just two weeks after the date of the fire, so that thereafter the service became normal. The second engine was started one week later, and the third engine was ready for service on June 3. It is believed that very little disturbance was experienced in any part of the Sewerage System, and great credit is due to the Chief Engineer and his assistants for their prompt and efficient work.

A temporary wooden roof and temporary windows and doors have been placed in the station and the whole put into proper working order. A special appropriation of \$40,000 for the restoration of the station and its equipment was authorized by the Legislature, and the larger part of the sum was expended during the year, but leaving some of the work to be done after permanent plans have been adopted.

The occurrence of the fire, however, induced the Board to defer for a time the construction of the enlargement of this station and to enter into a careful investigation as to the future requirements of the North Metropolitan System. This investigation has been made by Messrs. Mills and Stearns, consulting engineers of the Board, in connection with the Chief Engineer of Sewerage Works, Mr. Brown. It is probable that the work of enlargement of this station will be entered upon in the early spring.

(c) Stable and Locker Buildings.

The fire at Chelsea also caused the destruction of the group of small buildings used for stable, locker and general purposes for the North System, which were situated on the East Boston side of Chelsea Creek on Chelsea Street, opposite the station lands. The Board had called the attention of the Legislature to the necessity of erecting permanent buildings in place of the temporary structures upon the lot. After the fire, however, it was believed that it was desirable to make other arrangements, and, a favorable opportunity occurring, it was determined advisable to sell this lot with the im-

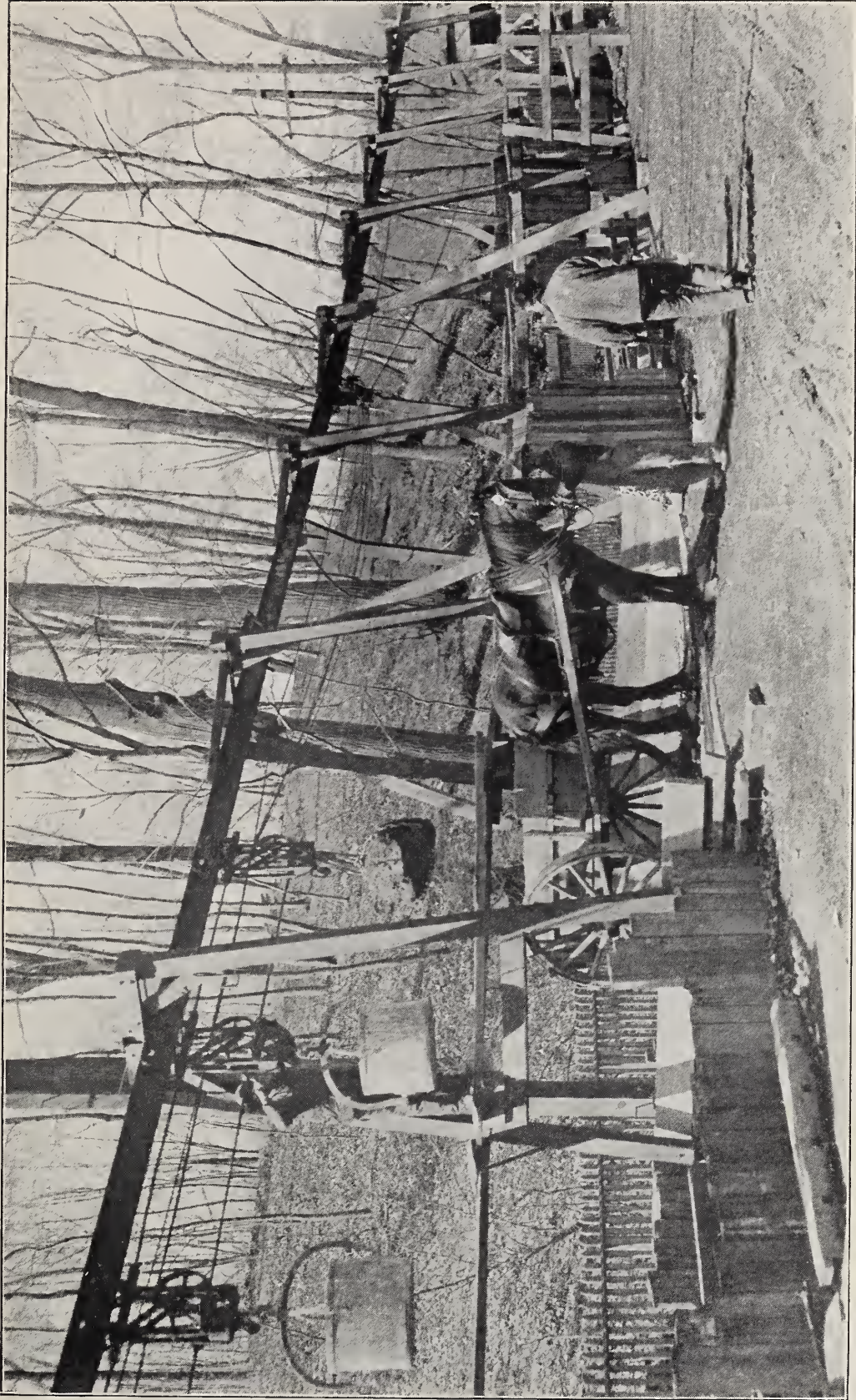
provements which had been made. This sale was accordingly made and the sum of \$17,500 was received. Under the special act of last year, which was passed after the fire, the Board was authorized to use any money received from the sale for the purchase of land and the erection of stable and locker buildings thereon. In the meantime, temporary arrangements have been made, and the selection of a site and the construction of new buildings have been deferred until a final determination is reached in regard to the enlargement of the East Boston pumping station.

(2) SOUTH METROPOLITAN SEWERAGE SYSTEM — CONSTRUCTION.

The extension of the High-level Sewer from the corner of Center and Perkins streets in Jamaica Plain through West Roxbury, Brookline and to Oak Square in Brighton, was authorized in the year 1906, and the work of construction has since been in progress. The entire length of the line of the extension is 5.64 miles, the sewer varying in size from 7 feet to 5 feet in diameter. The work was divided into seven sections, involving the making of thirteen contracts. Portions of two sections, however, were, for reasons given in the preceding report, constructed by day labor under the direct supervision of the Chief Engineer of the Sewerage Works.

All but 145 feet of the whole length has been completed and the work will be finished early in the current year. There are two uncompleted contracts. The most difficult part of the construction was in the vicinity of Jamaica Pond, which involved the building of a tunnel 2,919 feet in length under pneumatic processes. It was especially necessary to adopt means by which there should be no disturbance of the waters of the pond. This work was accordingly performed by day labor, and the Chief Engineer had the immediate assistance of a tried expert in this class of construction. The tunnel has been successfully completed at an expense considerably below the estimate. The entire extension has involved a large amount of rock excavation, and considerable difficulties have been encountered in other places in order to create as little disturbance as possible in residential districts.

The sum of \$559,166.41 was expended on this work during the year, making a total since the beginning of \$1,037,919.10. There is no doubt that the extension will be completed within the amount originally estimated and for which loans were authorized.



CONSTRUCTION OF HIGH-LEVEL SEWER EXTENSION IN BROOKLINE

(3) ACQUISITION OF LANDS AND SETTLEMENTS FOR LANDS
ACQUIRED.

There has been but a single taking during the year of land or easements for the Metropolitan Sewerage Works, and this was for the purpose of the extension of the High-level Sewer, as follows:—

List of Takings for Metropolitan Sewerage Works for the Year 1908.

No.	LOCATION AND DESCRIPTION.	Former Owner.	Recorded.	Purpose of Taking.
21	Brighton,— in Washington Street, between Lake Street and Oak Square. Area, easements in 4.88 acres.	Public street.	1908. May 11.	Section 86, South Metropolitan System.

During the year 1908 settlements on account of the takings made in the North Metropolitan District have been effected in 2 cases, involving a payment of \$460; and also in 2 cases in the South Metropolitan District settlements have been effected, under which payments have been made amounting to \$2,170.

Of the 4 sewerage settlements, 2 were on account of the sewer extensions to Malden and to Belmont, 1 on account of the extension of the High-level Sewer in Commonwealth Avenue, Boston, and 1 on account of an early taking for the High-level Sewer in Quincy.

Summary of Land Settlements for the Year 1908.

LOCATION.	Area in Acres.	Number of Settlements.	Payments.
<i>North Metropolitan District.</i>			
Malden, . . . . .	.018	1	\$250 00
Cambridge, . . . . .	.058	1	210 00
<i>South Metropolitan District.</i>			
Quincy, . . . . .	.712	1	120 00
Boston, . . . . .	.231	1	2,050 00
Aggregate,	1.019	4	\$2,630 00

(4) NORTH METROPOLITAN SYSTEM — MAINTENANCE.

The main sewers now maintained in the North Metropolitan System are 58.57 miles in length and with them are connected 639.50 miles of local sewers. The number of connections, public and special, with the North Metropolitan System is 672.

The East Boston and Charlestown districts of Boston and the cities of Everett, Cambridge, Somerville and Chelsea still maintain both separate and combined sewers, but all of the other municipalities in the North Metropolitan System maintain separate sewers, admitting sewage, but not directly admitting any rain water.

There have been pumped at the Alewife Brook pumping station 3,627,000 gallons of sewage per day, with an average lift of 12.87 feet, at a cost of \$0.466 per million gallons per foot lifted; at the Charlestown station 31,300,000 gallons per day, 8.15 feet lift, at a cost of \$0.179 per million gallons per foot lifted; at the East Boston station 57,800,000 gallons per day, 15.83 feet lift, at a cost of \$0.094 per million gallons per foot lifted; and at the Deer Island station 59,800,000 gallons per day, 10.50 feet lift, at a cost of \$0.106 per million gallons per foot lifted.

The total amount of coal, all of which is bituminous, which was purchased for use at the various stations, was 6,497.789 gross tons. The contract price per gross ton varied from \$3.69 to \$4.98.

During the year 9 public and 25 special connections from local sewers have been made with the system, and 14.76 miles of local sewers have been added to those already connected with its works.

The average amount of sewage discharged daily from the outfall off Deer Island was 59,800,000 gallons. The maximum daily rate of discharge for the year was reached on February 27, when it was for a short period about 138,500,000 gallons. The amount of sewage in the District averaged 141 gallons per day for each person, taking the estimated population of the district contributing sewage. The fact that a portion of the sewers in the District are combined sewers, directly admitting in part rain water, considerably increases the per capita amount.

There has been a decrease in the amount of sewage pumped at all of the stations. This decrease is largely due to the small rainfall, which was much below the normal amount. Some of the decrease was caused by the interruption in the sewage disposal on account of

the East Boston fire. There was consequently an increase in the cost per million gallons raised one foot.

The regular cost of maintenance of the North Metropolitan System during the past year was \$141,465.29, which is but slightly in excess of the cost of maintenance during the preceding year. To this amount, however, is to be added the sum of \$22,050.31, which was expended for the restoration of the East Boston pumping station under the special appropriation and charged to maintenance.

(5) SOUTH METROPOLITAN SYSTEM — MAINTENANCE.

In the South Metropolitan System the number of miles of main sewers maintained is 42.78, with which are connected 492.86 miles of local sewers, having 117 connections with the Metropolitan System.

The Back Bay, Roxbury, West Roxbury, Brighton and Dorchester districts of Boston and the towns of Brookline and Milton still maintain both separate and combined sewers, but all the other districts contributory to this system maintain separate sewers.

There has been pumped at the Ward Street station an average of 22,300,000 gallons of sewage per day, with an average lift of 40.73 feet, at a cost of \$0.083 per million gallons per foot lifted; and at the Quincy station 3,687,000 gallons, 21.04 feet lift, at an average cost of \$0.242 per million gallons per foot lifted.

The total amount of coal, all of which is bituminous, which was purchased for use at the various stations, was 2,727.303 gross tons. The contract price per gross ton varied from \$4.20 to \$5.25, the prices in this District exceeding those in the North District on account of the greater cost of transportation.

An average of 37,800,000 gallons of sewage has been discharged daily from the outfalls into the outer harbor. The maximum rate of discharge per day, which was 107,000,000 gallons, was reached for a period of about three hours on January 8.

The average discharge of sewage in the South Metropolitan System was at the rate of 187 gallons per day per person of the estimated number contributing sewage in the district. This larger per capita discharge is in part because the greater size of the High-level Sewer permits the admission of some storm water at periods of heavy rainfall.

All the sewage of the South Metropolitan System is now disposed

of through the outfall pipes off Nut Island, with the exception of that from a small area in the districts of Dorchester and Milton, which is so low that its sewage cannot be carried into the High-level Sewer except by pumping. The sewage of this area consequently is disposed of by the city of Boston through its main Drainage Works, and for this service a rental is paid to the city.

The expenditures for maintenance of the South Metropolitan System for the past year were \$97,945.60, a slight increase over the total required for last year.

VII. SEWERAGE WORKS — FINANCIAL STATEMENT.

The financial abstract of the receipts, expenditures, disbursements, assets and liabilities of the Metropolitan Water and Sewerage Board for the fiscal year of the Commonwealth ending with the thirtieth day of November, 1908, was, as stated in connection with the Water Works, presented to the General Court in January, in accordance with the requirements of chapter 235 of the Acts of the year 1906, and a copy of this financial abstract is in part printed as Appendix No. 5.

The following statement of its financial doings, in relation to the Metropolitan Sewerage Works, for the calendar year 1908, is herewith presented, in accordance with the provisions of the Act of 1906, as a part of the annual report of the Board.

The Metropolitan sewerage loans authorized for the construction of the Sewerage Works of the North Metropolitan System have amounted to \$6,573,865.73, to which are added receipts from various sources amounting to \$35,883.21. The amount of expenditures approved by the Board for payment for the year 1908 was \$25,141.96 and the total amount of expenditures approved to January 1, 1909, was \$6,171,165.12. The balance remaining on January 1, 1909, was \$438,583.82.

The loans authorized for the construction of the various parts of the South Metropolitan System have amounted to \$8,867,046.27. The receipts applicable to the loan fund have been \$11,406.82. The amount of expenditures approved for payment in the year 1908 was \$559,288.41. The total amount of expenditures approved for payment from the beginning of the works has been \$8,741,869.20.

The balance remaining for the South Metropolitan System on January 1, 1909, was \$136,583.89.

The bonds issued on account of the loans have been for varying periods, not exceeding forty years, and bear interest at the rate of 3 per cent. and 3½ per cent. The premiums received on account of the sale of bonds on the North Metropolitan System have amounted to \$175,518.65, and those received on account of the South Metropolitan System have amounted to \$410,132.03.

The amount expended for maintenance of the North Metropolitan System in the year 1908 was \$163,515.60 and for the South Metropolitan System \$97,945.69, a total for both systems of \$261,461.29.

The assessments made to meet interest, sinking fund requirements and maintenance and operation of the North Metropolitan System amounted in the year 1908 to \$426,267.84 and the assessments for the South Metropolitan System amounted to \$450,741.38.

The following is a detailed financial statement regarding the Metropolitan Sewerage Works:—

(1) METROPOLITAN SEWERAGE LOANS, RECEIPTS AND PAYMENTS.

The loans authorized for the construction of the Metropolitan Sewerage Works, the receipts which are added to the proceeds of these loans, and the expenditures for construction, have been as follows:—

(a) *North Metropolitan System.*

Loans under various acts of the Legislature (given in detail in report for the year 1901),		\$5,605,865 73
Loans under chapters 242, 336 and 399, Acts of 1903,		500,000 00
Loan under chapter 319, Acts of 1906,		55,000 00
Loan under chapter 556, Acts of 1908,		413,000 00
		<hr/>
		\$6,573,865 73
Proceeds from sales of property and from other sources to December 31, 1908 (of which \$18,729.81 is for the year 1908),		35,883 21
		<hr/>
		\$6,609,748 94
Amount approved by the Metropolitan Sewerage Commission and the Metropolitan Water and Sewerage Board for payment to December 31, 1908 (of which \$25,141.96 is for the year 1908),		6,171,165 12
		<hr/>
Balance, North Metropolitan System, January 1, 1909,		\$438,583 82

(b) South Metropolitan System.

Loans under the acts of the years 1889 and 1900 (Charles River Valley Sewer),	\$800,046 27
Loans under various acts of the Legislature (given in detail in report for the year 1901, Neponset River Valley Sewer), .	900,000 00
Loan under chapter 315 of the Acts of 1903 (Neponset River Valley Sewer),	4,000 00
Loan under chapter 424 of the Acts of 1899,	4,600,000 00
Loan under chapter 356 of the Acts of 1903,	996,000 00
Loans under chapters 230 and 246 of the Acts of 1904, . . .	392,000 00
Loan under chapter 406 of the Acts of 1906,	1,175,000 00
Proceeds from sales of property and other sources to December 31, 1908 (of which \$1,300.22 is for the year 1908), . . .	11,406 82
	<hr/>
	\$8,878,453 09
Amount approved by the Metropolitan Sewerage Commission and the Metropolitan Water and Sewerage Board for payment to December 31, 1908 (of which \$559,288.41 is for the year 1908),	8,741,869 20
	<hr/>
Balance, South Metropolitan System, January 1, 1909, . . .	\$136,583 89

(2) ISSUES OF METROPOLITAN SEWERAGE LOAN BONDS.

The Treasurer of the Commonwealth, under the authority of the successive statutes, has from time to time issued bonds designated "Metropolitan Sewerage Loan," as follows:—

METROPOLITAN SEWER LOANS, NORTH SYSTEM.

Bonds issued.

DATE OF SALE.	Amount of Bonds sold.	Rate of Interest (Per Cent.).	Price received.	Date due.	Premium.
Apr. 2, 1890,	\$500,000	3	102.40	Jan. 1, 1930,	\$12,000 00
Apr. 2, 1890,	500,000	3	103.02	Jan. 1, 1930,	15,100 00
Apr. 2, 1890,	500,000	3	103.62	Jan. 1, 1930,	18,100 00
Apr. 2, 1890,	500,000	3	102.327	Jan. 1, 1930,	11,635 00
Apr., 1890,	200,000	3	103.	Jan. 1, 1930,	6,000 00
Feb., 1891,	50,000	3	104.	Jan. 1, 1930,	} 35,130 30 ¹
Mar., 1891,	300,000	3	104.	Jan. 1, 1930,	
Mar., 1891,	18,000	3	104.	Jan. 1, 1930,	
Jan., 1892,	35,000	3	100.	Jan. 1, 1930,	-
Feb., 1892,	29,000	3	100.	Jan. 1, 1930,	-
Mar., 1892,	50,000	3	101.	Jan. 1, 1930,	500 00
June, 1892,	436,000	3	101.50	Jan. 1, 1930,	} 11,060 00 ¹
July, 1892,	150,000	3	101.50	Jan. 1, 1930,	
Aug., 1892,	150,000	3	101.50	Jan. 1, 1930,	
Nov., 1892,	3,000	3	100.50	Jan. 1, 1930,	15 00
Nov., 1892,	200,000	3	100.	Jan. 1, 1930,	-
Jan., 1893,	35,000	3	100.50	Jan. 1, 1930,	175 00
Jan., 1893,	25,000	3	100.50	Jan. 1, 1930,	125 00
Feb., 1893,	20,000	3	101.	Jan. 1, 1930,	200 00
Feb., 1893,	5,000	3	100.50	Jan. 1, 1930,	25 00
Feb., 1893,	400,000	3	100.25	Jan. 1, 1930,	1,000 00
Mar., 1893,	94,000	3	100.25	Jan. 1, 1930,	235 00
May 1, 1894,	464,000	3	100.	Jan. 1, 1930,	-
Oct., 1894,	4,000	3	100.	Jan. 1, 1930,	-
Oct., 1894,	1,000	3	100.	Jan. 1, 1930,	-
Nov., 1894,	15,000	3	100.	Jan. 1, 1930,	-
Nov., 1894,	10,000	3	100.	Jan. 1, 1930,	-
Dec., 1894,	6,000	3	100.	Jan. 1, 1930,	-
Apr., 1895,	300,000	3	100.	Jan. 1, 1930,	-
Dec., 1896,	30,000	3	100.	Jan. 1, 1930,	-
June, 1897,	70,000	3½	106.243	Jan. 1, 1930,	} 5,084 80 ¹
June, 1897,	10,000	3½	106.243	Jan. 1, 1930,	
Apr., 1898,	5,000	3	100.	Jan. 1, 1930,	} 22,843 75 ¹
June, 1898,	155,000	3½	100.	Jan. 1, 1930,	
June, 1898,	60,000	3½	100.	Jan. 1, 1930,	
Apr., 1900,	265,000	3	103.948	Jan. 1, 1930,	10,462 20
May, 1903,	200,000	3½	104.9797	Jan. 1, 1930,	9,959 40
May, 1903,	50,000	3½	106.2424	Jan. 1, 1943,	3,121 20
July, 1903,	250,000	3½	104.419	July 1, 1943,	11,047 50
June, 1906,	55,000	3½	103.09	July 1, 1943,	1,699 50
	\$6,150,000				\$175,518 65

¹ Readjustment of Treasurer.

METROPOLITAN SEWER LOANS, SOUTH SYSTEM.

Bonds issued.

DATE OF SALE.	Amount of Bonds sold.	Rate of Interest (Per Cent.).	Price received.	Date due.	Premium.
Apr., 1890,	\$100,000	3	103.	Jan. 1, 1930,	\$3,000 00
Apr., 1890,	400,000	3	103.	Jan. 1, 1930,	12,000 00
May, 1890,	300,000	3	104.	Jan. 1, 1930,	12,000 00
Aug., 1895,	300,000	3	100.585	Mar. 1, 1935,	1,755 00
Feb., 1896,	50,000	3	100.	Mar. 1, 1935,	-
Dec., 1896,	135,000	3	100.	Mar. 1, 1935,	-
Dec., 1896,	15,000	3	100.	Mar. 1, 1935,	-
June, 1897,	300,000	3½	106.98	Mar. 1, 1935,	20,940 00
June, 1898,	35,000	3½	100.	Mar. 1, 1935,	4,088 00 ¹
June, 1899,	25,000	3	100.64	Mar. 1, 1936,	160 00
June, 1899,	1,000,000	3	100.64	July 1, 1939,	6,400 00
Sept., 1900,	10,000	3	100.79	July 1, 1939,	79 00
Sept., 1900,	912	3	100.	July 1, 1939,	-
Apr., 1901,	40,000	3	100.915	Mar. 1, 1936,	366 00
Sept., 1901,	2,000,000	3½	106.71	July 1, 1940,	134,200 00
Sept., 1902,	14,000	3	100.	July 1, 1939,	-
Sept., 1902,	500,000	3½	107.243	July 1, 1940,	36,215 00
Sept., 1902,	150,000	3½	107.2395	July 1, 1940,	10,859 25
Dec., 1902,	200,000	3½	107.79	July 1, 1940,	15,580 00
Feb., 1903,	100,000	3½	108.25	July 1, 1940,	8,230 56 ¹
Apr., 1903,	100,000	3½	106.75	July 1, 1940,	6,750 00
Apr., 1903,	175,000	3½	106.75	July 1, 1940,	11,812 50
Apr., 1903,	203,000	3½	106.75	July 1, 1940,	13,702 50
Apr., 1903,	25,000	3½	106.494	July 1, 1940,	1,623 50
Apr., 1903,	133,000	3½	105.9364	July 1, 1940,	7,895 42
May, 1903,	996,000	3½	106.2424	Jan. 1, 1943,	62,174 31
May, 1903,	4,000	3½	105.5453	Mar. 1, 1935,	221 81
July, 1904,	392,000	3½	104.929	July 1, 1944,	19,321 68
June, 1906,	154,000	3½	103.09	Jan. 1, 1946,	4,758 60
June, 1906,	21,000	3½	103.09 ²	Jan. 1, 1946,	648 90
Apr., 1907,	300,000	3½	101.85	Jan. 1, 1947,	5,550 00
Apr., 1908,	700,000	3½	101.40	Jan. 1, 1946,	9,800 00
	\$8,877,912				\$410,132 03

¹ Readjustment of Treasurer.

² Not issued or delivered until 1907.

(3) METROPOLITAN SEWERAGE LOANS SINKING FUND.

Under authority of chapter 122 of the Acts of 1899, and section 14 of chapter 424 of the Acts of 1899, the Treasurer of the Commonwealth was required to consolidate the sinking funds of all the Metropolitan sewerage loans into one fund, to be known as the Metropolitan Sewerage Loans Sinking Fund.

The Board received, during the year, from rentals and from other sources, to be applied to the sinking fund, \$172.41.

The sinking fund established has amounted at the end of each year to sums as follows:—

December 31, 1899,	. \$361,416 59	December 31, 1904,	. \$878,557 12
December 31, 1900,	. 454,520 57	December 31, 1905,	. 1,008,724 95
December 31, 1901,	. 545,668 26	December 31, 1906,	. 1,146,998 68
December 31, 1902,	. 636,084 04	December 31, 1907,	. 1,306,850 30
December 31, 1903,	. 754,690 41	December 31, 1908,	. 1,492,418 98

(4) ANNUAL APPROPRIATIONS, RECEIPTS AND EXPENDITURES.

The annual appropriations for the maintenance of the Metropolitan Sewerage Works, the receipts of the Board which are added to the appropriations for maintenance, and the expenditures for maintenance for the year ending December 31, 1908, have been as follows:—

North Metropolitan System.

Appropriations under chapters 211 and 582 of the Acts of 1908,	. \$186,000 00
Receipts from pumping and from other sources,	. 618 92
	<hr/>
	\$186,618 92
Amount approved by the Board for payment,	. 163,515 60
	<hr/>
Balance January 1, 1909,	. \$23,103 32 ¹

South Metropolitan System.

Appropriation under chapter 213 of the Acts of 1908,	. \$105,000 00
Receipts from pumping and from other sources,	. 151 53
	<hr/>
	\$105,151 53
Amount approved by the Board for payment,	. 97,945 69
	<hr/>
Balance January 1, 1909,	. \$7,205 84

¹ Of this balance, \$17,284.43 is the remaining portion of the special appropriation of \$40,000 made by chapter 582 of the Acts of 1908 for the restoration and equipment of the East Boston pumping station, on account of the Chelsea fire of April 12, 1908.

(5) ANNUAL ASSESSMENTS.

Assessments for the year, amounting to \$426,267.84 for the North Metropolitan System and to \$450,741.38 for the South Metropolitan System, were required for the payment of interest and sinking fund requirements and the cost of maintenance and operation of works. The requirements for the North Metropolitan System were: for interest, \$191,340.19; for the sinking fund, \$54,569.65; and for maintenance, \$180,358. For the South Metropolitan System the requirements were: for interest, \$294,682.42; for the sinking fund, \$54,712.28; and for maintenance, \$101,346.68. The assessments for the North Metropolitan System were made upon the cities and towns in the District in accordance with chapter 369 of the Acts of the year 1906, and the assessments for the South Metropolitan System were made in accordance with ratios fixed by the Apportionment Commissioners appointed under the provisions of chapter 424 of the Acts of the year 1899. The respective assessments were as follows:—

North Metropolitan Sewerage System.

Arlington, . . .	\$9,507 36	Somerville, . . .	\$59,602 25
Belmont, . . .	5,200 39	Stoneham, . . .	5,343 13
Boston, . . .	75,261 26	Wakefield, . . .	8,659 83
Cambridge, . . .	99,768 95	Winchester, . . .	9,285 97
Chelsea, . . .	28,155 30	Winthrop, . . .	7,605 53
Everett, . . .	23,092 42	Woburn, . . .	11,943 75
Lexington, . . .	3,638 02	Revere, . . .	11,596 12
Malden, . . .	33,189 92		
Medford, . . .	20,019 71	Total, . . .	\$426,267 84
Melrose, . . .	14,397 93		

South Metropolitan Sewerage System.

Boston, . . .	\$186,834 48	Quincy, . . .	\$27,109 15
Brookline, . . .	83,757 57	Waltham, . . .	26,527 72
Dedham, . . .	11,069 82	Watertown, . . .	13,384 05
Hyde Park, . . .	14,433 24		
Milton, . . .	21,451 65	Total, . . .	\$450,741 38
Newton, . . .	66,173 70		

(6) EXPENDITURES FOR THE DIFFERENT WORKS.

The following is a summary of the expenditures made in the various operations for the different works:—

CONSTRUCTION AND ACQUISITION OF WORKS.	For the Year ending December 31, 1908.	From Beginning of Work to December 31, 1908.
<i>North Metropolitan System.</i>		
Original system, main line and branches,	\$25 00	\$5,383,957 67
Lexington branch,	-	68,585 15
Everett branch,	-	54,877 12
Wakefield branch,	-	35,698 29
Stoneham branch,	-	11,574 10
Revere extension,	-	215,722 79
Chelsea and Everett outlets,	-	71,216 41
Wakefield branch extension,	-	190,081 97
Belmont extension,	210 00	57,363 06
Malden extension: —		
Administration,	-	\$3,610 46
Section 64,	\$218 75	46,048 69
Land takings, purchase and recording,	250 85	4,689 90
	469 60	54,349 05
Bulkhead, Chelsea Creek,	-	3,231 00
Stable and locker, East Boston,	-	71 15
North System, enlargement: —		
Administration,	\$661 66	\$661 66
Deer Island pumping station, extensions and additions,	22,462 34	22,462 34
East Boston pumping station, extensions and additions,	1,313 36	1,313 36
	24,437 36	24,437 36
Total North Metropolitan System,	\$25,141 96	\$6,171,165 12
<i>South Metropolitan System.</i>		
Charles River valley sewer, main line,	-	\$800,046 27
Neponset River valley sewer: —		
Main line,	-	\$866,595 66
Brookline branch,	-	44,935 80
		911,531 46
High-level Sewer: —		
Administration,	-	\$51,621 43
Apportionment commission,	-	2,000 00
Land takings, purchase and recording,	\$122 00	355,623 45
Quincy force main,	-	18,351 71
Quincy pumping station,	-	11,705 68
Section 43, Quincy,	-	411,749 22
Section 44, Quincy,	-	299,543 47
Section 45, Quincy,	-	76,139 36
Section 46, Quincy,	-	62,551 26
Section 47, Quincy,	-	109,786 58
Section 48, Quincy,	-	295,319 29
Sections 48 and 49, embankments, Quincy,	-	81,548 64
Section 49, Quincy,	-	169,020 18
Section 50, Quincy,	-	109,570 35
Section 51, Quincy,	-	87,203 68
Section 52, Quincy,	-	155,800 65
Amounts carried forward,	\$122 00	\$2,297,534 95 \$1,711,577 73

CONSTRUCTION AND ACQUISITION OF WORKS.	For the Year ending December 31, 1908.	From Beginning of Work to December 31, 1908.
<i>Amounts brought forward,</i>	\$122 00	\$2,297,534 95 \$1,711,577 73
<i>South Metropolitan System — Con.</i>		
High-level Sewer — <i>Con.</i>		
Section 53, Quincy,	-	98,042 42
Section 54, Quincy,	-	101,918 39
Section 55, Milton and Quincy,	-	305,816 90
Section 56, Milton,	-	105,736 94
Section 57, Milton,	-	68,783 24
Section 58, Milton,	-	94,039 72
Section 59, Milton,	-	104,444 62
Section 60, Milton,	-	60,796 13
Section 61, Milton,	-	129,598 76
Section 62, Milton,	-	129,612 28
Section 63, Milton,	-	127,142 45
Section 64, Neponset River crossing, . .	-	47,554 40
Section 65, Hyde Park,	-	41,333 37
Section 66, Hyde Park,	-	253,902 72
Section 67, Hyde Park, Stony Brook crossing,	-	32,298 33
Section 68, Hyde Park and Roxbury, . .	-	78,493 62
Section 69, West Roxbury,	-	102,143 68
Section 70, West Roxbury,	-	131,375 55
Section 71, West Roxbury,	-	91,888 22
Section 72, West Roxbury,	-	127,956 76
Section 73, West Roxbury,	-	494,290 42
Section 74, West Roxbury and Roxbury, .	-	147,296 69
Section 75, Roxbury,	-	137,192 99
Section 76, Roxbury, cast-iron force main, .	-	80,342 26
Section 77, Roxbury, Ward Street pumping station,	-	560,288 31
Section 78, Roxbury, connecting sewer, .	-	35,994 69
Reversion of grade, Huntington Avenue, .	-	6,503 56
	122 00	5,992,372 37
High-level Sewer extension: —		
Charles River valley studies,	-	\$3,893 71
Administration,	\$6,497 59	12,829 76
Section 80, day work, West Roxbury and Brookline,	94,916 02	294,961 91
Section 81, Brookline,	118,465 91	122,685 07
Section 82, Brookline,	21,904 71	135,927 31
Section 82, day work, Park street crossing, .	10 64	2,030 18
Section 83, Brookline,	63,441 91	93,818 87
Section 84, Brookline and Brighton, . .	2,540 30	47,592 89
Section 85, Brighton,	205,260 61	206,007 24
Section 85, day work, Brighton,	357 01	66,611 62
Section 86, Brighton,	43,598 46	43,639 46
Land takings, purchase and recording, .	2,173 25	7,921 08
	559,166 41	1,037,919 10
Total for South Metropolitan System,	\$559,288 41	\$8,741,869 20
Total for construction for both systems,	\$584,430 37	\$14,913,034 32

MAINTENANCE.	For the Year ending December 31, 1908.	From Beginning of Work to December 31, 1908.
North Metropolitan System,	\$163,515 60	\$1,429,759 39
South Metropolitan System,	97,945 69	1,212,005 74
Total for maintenance, both systems,	\$261,461 29	\$2,641,765 13

(7) DETAILED FINANCIAL STATEMENT.

The Board herewith presents, in accordance with the Metropolitan Sewerage Acts, an abstract of the expenditures and disbursements, receipts, assets and liabilities for the year ending December 31, 1908:—

(a) *Expenditures and Disbursements.*

GENERAL CHARACTER OF EXPENDITURES.	For the Year ending December 31, 1908.
CONSTRUCTION OF WORKS AND ACQUISITION BY PURCHASE OR TAKING.	
<i>North Metropolitan System.</i>	
Original system, main line and branches:—	
Land takings, purchase and recording,	\$25 00
	25 00
Administration:—	
Commissioners,	—
Secretary,	—
Clerks and stenographers,	\$528 00
Travelling,	—
Stationery, printing and office supplies,	72 49
Telephone, lighting, heating, water and care of building,	53 58
Rent and taxes, main office,	7 59
Miscellaneous expenses,	—
	661 66
Engineering:—	
Chief engineer,	—
Engineering assistants,	\$2,891 96
Inspectors,	—
Travelling expenses,	54 30
Stationery, printing and office supplies,	125 74
Engineering and drafting instruments and tools,	—
Engineering and drafting supplies,	57 03
Telephone, lighting, heating, water and care of building,	162 73
Rent and taxes,	22 77
Miscellaneous expenses,	538 14
	3,852 67
Amount carried forward,	\$4,539 33

GENERAL CHARACTER OF EXPENDITURES.	For the Year ending December 31, 1908.	
<i>Amount brought forward,</i>		\$4,539 33
<i>North Metropolitan System — Con.</i>		
Advertising,	-	
Labor and teaming,.	\$8,751 68	
Tools, machinery and appliances,	450 88	
Brick, cement, lumber and other field supplies and expenses,	10,720 47	
		19,923 03
Contracts: —		
Sundry bills paid under contract 64,	\$218 75	
Real estate: —		
Settlements,	460 00	
Legal, conveyancing and expert,	85	
		679 60
Total for North Metropolitan System,		\$25,141 96
<i>South Metropolitan System.</i>		
<i>High-level Sewer: —</i>		
Administration: —		
Telephone, lighting, heating, water and care of building,	-	
Miscellaneous expenses,	-	
		-
Engineers, inspectors, rodmen, laborers and others,	-	
Tools and repairs of same,	-	
Brick, cement, lumber and other field supplies,	-	
Teaming and express,	-	
Land takings, purchase and recording,	\$122 00	
		\$122 00
<i>High-level Sewer Extension: —</i>		
Administration: —		
Commissioners,	\$3,500 00	
Secretary,	1,125 00	
Clerks and stenographers,	1,348 00	
Travelling,	-	
Stationery, printing and office supplies,	115 40	
Telephone, lighting, heating, water and care of building,	196 99	
Rent and taxes, main office,	212 20	
Miscellaneous expenses,	-	
		\$6,497 59
Engineering: —		
Chief engineer,	\$3,333 33	
Engineering assistants,	16,677 69	
Inspectors,	12,433 35	
Travelling expenses,	701 20	
Stationery, printing and office supplies,	409 07	
Engineering and drafting instruments and tools,	114 54	
Engineering and drafting supplies,	254 22	
Telephone, lighting, heating, water and care of building,	770 34	
<i>Amounts carried forward,</i>	\$34,693 74	\$6,497 59 \$122 00

GENERAL CHARACTER OF EXPENDITURES.		For the Year ending December 31, 1908.	
<i>Amounts brought forward,</i>	\$34 693 74	\$6,497 59	\$122 00
<i>South Metropolitan System — Con.</i>			
<i>High-level Sewer Extension — Con.</i>			
Engineering — <i>Con.</i>			
Rent and taxes,	756 48		
Miscellaneous expenses,	961 69		
		36,411 91	
Advertising,	\$105 19		
Labor and teaming,	59,236 87		
Tools, machinery and appliances,	237 32		
Brick, cement, lumber and other field supplies and expenses,	35,419 96		
Contracts: —			
Bruno & Petitti, Section 81, in part,	59,307 70		
Hugh Nawn Contracting Co., Section 81, in part,	50,601 33		
James Driscoll & Son, Section 82, in part,	6,436 39		
Timothy J. O'Connell, Section 82, in part,	6,944 96		
Timothy J. O'Connell, Section 82, in part,	7,536 61		
Chas. G. Craib & Co., Section 83, in part,	3,975 15		
Timothy J. O'Connell, Section 83, in part,	53,855 14		
D. F. O'Connell, Section 84,	2,354 82		
Geo. M. Bryne Co., Section 85, in part,	47,661 63		
Hugh Nawn Contracting Co., Section 85, in part,	68,485 40		
D. F. O'Connell Co., Section 85, in part,	75,718 00		
Glenn & Broderick, near Section 86,	6,993 96		
Chas. J. Jacobs Co., Section 86,	29,113 23		
		514,033 66	
Real estate: —			
Settlements,	\$2,132 27		
Legal, conveyancing and expert,	40 98		
		2,173 25	
			559,166 41
Total for South Metropolitan System,			\$559,288 41
MAINTENANCE AND OPERATION OF WORKS.			
<i>North Metropolitan System.</i>			
Administration: —			
Commissioners, secretary and assistants,	\$4,310 52		
Postage, printing, stationery and office supplies,	699 12		
Rent, telephone, heating, lighting and care of building,	506 15		
Miscellaneous expenses,	63 03		
			\$5,578 82
General superintendence: —			
Chief engineer and assistants,	\$4,990 00		
Postage, printing, stationery and office supplies,	273 95		
Rent, telephone, heating, lighting and care of building,	1,519 55		
Miscellaneous expenses,	231 93		
			7,015 43
<i>Amount carried forward,</i>			\$12,594 30

GENERAL CHARACTER OF EXPENDITURES.	For the Year ending December 31, 1908.
<i>Amount brought forward,</i>	\$12,594 30
<i>North Metropolitan System — Con.</i>	
Deer Island pumping station: —	
Labor,	\$14,512 92
Coal,	9,485 40
Oil and waste,	361 15
Water,	1,220 40
Packing,	133 21
Repairs and renewals,	1,021 29
Telephone and office supplies,	201 30
Miscellaneous supplies and expenses,	580 64
East Boston pumping station: —	
Labor,	18,031 58
Coal,	11,694 59
Oil and waste,	521 92
Water,	1,726 00
Packing,	498 21
Repairs and renewals,	2,917 22
Telephone and office supplies,	198 85
Miscellaneous supplies and expenses,	1,510 95
Charlestown pumping station: —	
Labor,	14,399 33
Coal,	3,031 90
Oil and waste,	278 16
Water,	494 40
Packing,	56 42
Repairs and renewals,	362 67
Telephone and office supplies,	158 72
Miscellaneous supplies and expenses,	524 00
Alewife Brook pumping station: —	
Labor,	7,826 35
Coal,	2,156 52
Oil and waste,	231 80
Water,	181 56
Packing,	58 67
Repairs and renewals,	708 24
Telephone and office supplies,	118 33
Miscellaneous supplies and expenses,	146 52
95,349 22	
Sewer lines, labor,	\$23,998 54
Supplies and expenses,	3,915 48
27,914 02	
Horses, vehicles and stable account,	\$4,942 49
Renewal East Boston pumping station, account Chelsea fire, April 12,	
1908, labor,	6,939 16
Supplies and expenses,	15,776 41
27,658 06	
Total for North Metropolitan System,	\$163,515 00

GENERAL CHARACTER OF EXPENDITURES.	For the Year ending December 31, 1908.
<i>South Metropolitan System.</i>	
Administration: —	
Commissioners, secretary and assistants,	\$3,742 41
Postage, printing, stationery and office supplies,	638 82
Rent, telephone, heating, lighting and care of building,	498 77
Miscellaneous expenses,	12 00
	\$4,892 00
General superintendence: —	
Chief engineer and assistants,	\$4,380 93
Postage, printing, stationery and office supplies,	116 24
Rent, telephone, heating, lighting and care of building,	1,495 60
Miscellaneous expenses,	341 50
	6,334 27
Ward Street pumping station: —	
Labor,	\$19,113 63
Coal,	9,648 44
Oil and waste,	365 88
Water,	1,359 60
Packing,	336 22
Repairs and renewals,	1,119 87
Telephone and office supplies,	132 98
Miscellaneous supplies and expenses,	1,081 69
Quincy pumping station: —	
Labor,	6,427 00
Coal,	1,799 94
Oil and waste,	30 56
Water,	212 70
Packing,	88 62
Repairs and renewals,	99 88
Telephone and office supplies,	48 24
Miscellaneous supplies and expenses,	411 91
Nut Island screen-house: —	
Labor,	7,190 50
Coal,	983 46
Oil and waste,	51 45
Water,	307 82
Packing,	36 65
Repairs and renewals,	104 50
Telephone and office supplies,	94 30
Miscellaneous supplies and expenses,	2,343 56
	53,394 40
Sewer lines, labor,	\$20,669 17
Supplies and expenses,	1,633 58
	22,302 75
City of Boston, for pumping and interest,	7,700 00
Horses, vehicles and stable account,	3,322 27
Total for South Metropolitan System,	\$97,945 69

(b) *Receipts.*

The receipts from the sales of property, from rents and from other sources, have been credited as follows: —

ACCOUNT.	For Year ending December 31, 1908.	From Beginning of Work to December 31, 1908.
North Metropolitan System, — construction, . .	\$18,729 81	\$35,883 21
South Metropolitan System, — construction, . .	1,300 22	11,406 82
North Metropolitan System, — maintenance, . .	618 92	10,033 92
South Metropolitan System, — maintenance, . .	151 53	1,253 71
Metropolitan Sewerage Loans Sinking Fund, . .	172 41	1,191 82
Totals,	\$20,972 89	\$59,769 48

(c) *Assets.*

The following is an abstract of the assets of the Sewerage Works, a complete schedule of which is kept on file in the office of the Board: —

Office furniture, fixtures and supplies; engineering and scientific instruments and supplies; horses, vehicles, field machinery, etc.; machinery, tools and other appliances and supplies; real estate connected with works not completed; completed works, including real estate connected therewith.

(d) *Liabilities.*

There are liabilities as follows: —

Due on monthly pay rolls, \$1,081 49

There are other current bills unpaid, which have not yet been received.

Amounts on Monthly Estimates, not due until Completion of Contracts or until Claims are settled.

NAME.	Work.	Amount.
High-level Sewer:—		
National Contracting Co., . . .	Sect. 73, contract abandoned,	\$5,516 17 ¹
E. W. Everson & Co., . . .	Sect. 75,	1,000 00
High-level Sewer Extension:—		
Bruno & Petitti,	Sect. 81, in part, . . .	4,583 82
Hugh Nawn Contracting Co., . .	Sect. 81, in part, . . .	1,605 49
Timothy J. O'Connell,	Sect. 82, in part, . . .	60 00
Geo. M. Bryne Co.,	Sect. 85, in part, . . .	2,508 51
Hugh Nawn Contracting Co., . .	Sect. 85, in part, . . .	1,946 60
D. F. O'Connell Co.,	Sect. 85, in part, . . .	13,362 00
Glenn & Broderick,	Sect. 86, in part, . . .	1,336 67
Chas. J. Jacobs Co.,	Sect. 86,	5,137 60
North Metropolitan Construction:—		
T. H. Gill & Co.,	Sect. 64,	2,425 90
		\$39,482 76

¹ Damages claimed by the Commonwealth on account of the abandonment of the contract exceed this amount.

On the claims of the following it is impossible to state the amounts due for land and other damages, as no sums have been agreed upon, and suits are now pending in the courts for the determination of most of them:—

Anna L. Dunican, Carrie S. Urquhart, N. Jefferson Urquhart, Edwin N. Urquhart, Richard Jones, James Doherty, Michael Niland, William H. Gibbons, Francis Normile, George A. Goddard, Boston & Albany Railroad Company.

VIII. CONSUMPTION OF WATER.

The average daily consumption of water in the cities and towns supplied by the Metropolitan Water Works amounted to 127,301,000 gallons. This was an increase in the total daily consumption over that of last year of 2,230,000 gallons. The average daily consumption per inhabitant during the year was 134.7 gallons, an increase in the daily per capita consumption of 0.9 of a gallon. These are the amounts as determined at the pumping stations and by the flow through the Weston Aqueduct, and include the estimated yield of

Spot Pond. The average daily quantity of water measured by the Venturi meters as delivered to the various municipalities is, owing to leakages from the reservoirs and pipe lines and slightly to the use of water at the pumping stations, somewhat less than the amount above given, the average daily quantity consumed, according to the latter measurement, being 125,441,000 gallons, which is equal to 133 gallons per inhabitant. The consumption of water, therefore, increased in a proportion rather closely corresponding to the increase of the population, the per capita consumption being but slightly greater than that in the preceding year.

The year was, on the whole, favorable to a lesser consumption, owing more especially to the circumstance that there were fewer considerable periods of continued very cold weather. The extreme dry weather of the warm season prevailed largely after the time when the demand is made for the sprinkling of lawns and the watering of vegetable gardens. There was, however, a marked increase in the consumption for certain consecutive days or weeks during the summer over similar periods in any previous year.

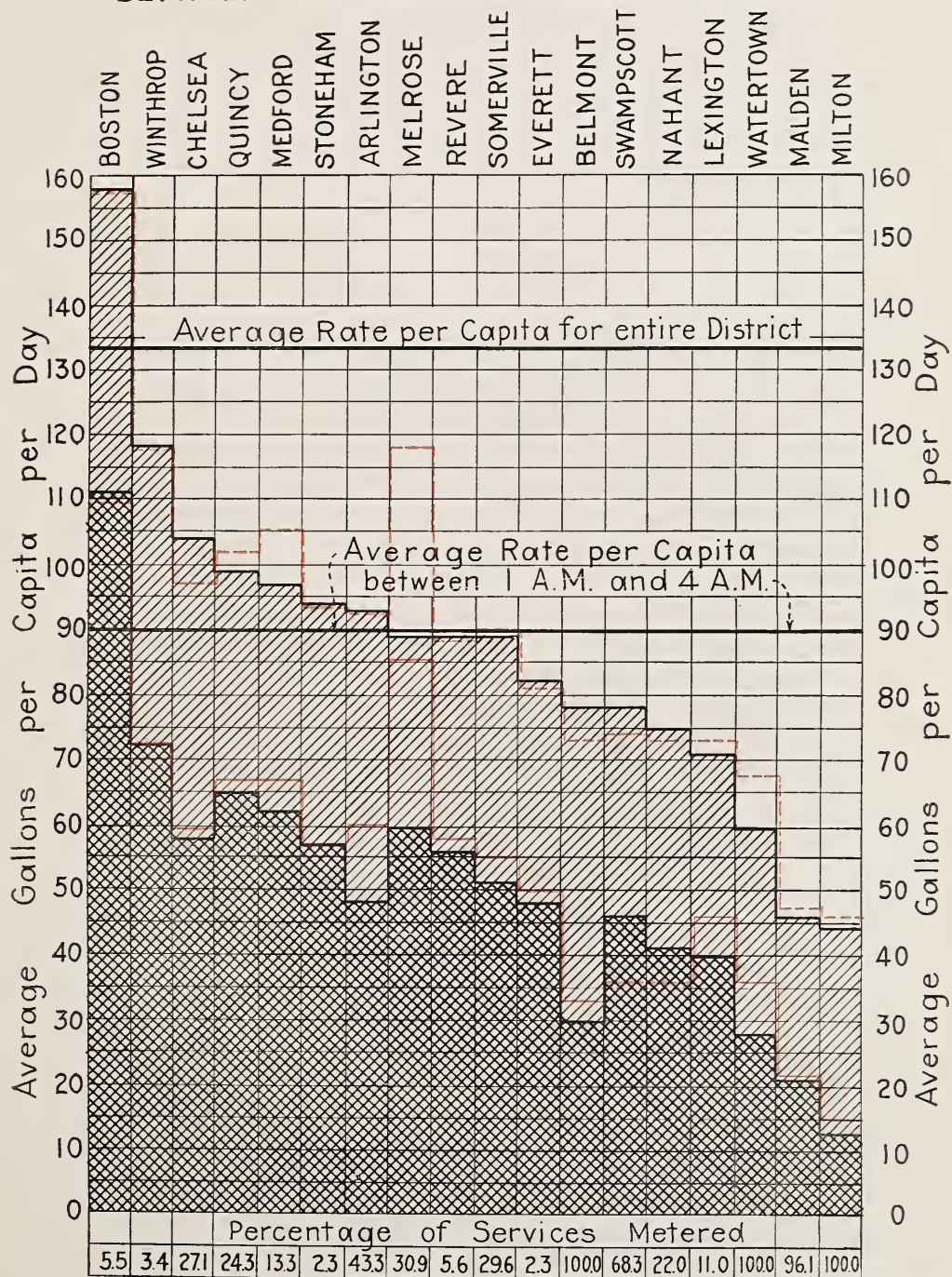
There was an increase in the daily per capita consumption in 10 municipalities and a decrease in 8 municipalities. The large amount of water which is wasted or unnecessarily consumed is again illustrated by the accompanying diagram, which shows the average rate of consumption during the entire day, and the average rate of consumption at night between 1 A.M. and 4 A.M., the rates of consumption in each case being compared with the average rates in the preceding year. The quantity of water passing through the pipes between the hours of 1 and 4 in the morning, when there is certainly a very small quantity used for any legitimate or necessary purpose, amounts in the entire district to an average daily rate of 84,972,000 gallons, which is 68 per cent. of the entire consumption, and amounts to 90 gallons per inhabitant. The average daily consumption during these hours for the coldest week of the year, February 1 to February 8, was 151,873,000 gallons, or 21 per cent. above the average of the year for the entire day.

These figures are conclusive in showing that a large proportion of the water furnished to the District is wasted, and that this waste occurs to a great extent on account of leakages in the local water pipes and bad plumbing in the houses.

The meter act, so called, passed by the Legislature in the year

DIAGRAM SHOWING
AVERAGE RATE OF CONSUMPTION OF WATER
IN THE METROPOLITAN DISTRICT IN 1908
DURING THE ENTIRE DAY

AND
BETWEEN THE HOURS OF 1 AND 4 AT NIGHT



Daily Average Rate of Consumption 1908.....
 " " " Night between 1 A.M. and 4 A.M. 1908.
 Daily Average Rates of Consumption in 1907 shown in Red

1907, went into effect only at the beginning of the year 1908. Its provisions required that all water services installed after December 31, 1907, should be metered, that after that date 5 per cent. of the water services which were then unmetered should annually be equipped with water meters, and that thereafter each consumer should be charged in proportion to the amount of water used. The returns furnished to the Board indicate that the provisions of the act have been substantially complied with by all of the municipalities of the District except the city of Boston and the town of Revere. The city of Boston reports that nothing has been done in the way of supplying meters under the provisions of the act. In the town of Revere there has been a partial compliance with the act, but neither all the new services nor the required percentage of old services have been installed.

Several of the cities and towns have been installing meters at a much greater rate than is required by the act, apparently with the intention that all of the water services shall be metered at an early date. All the services in the towns of Milton, Belmont and Watertown and the city of Melrose are now metered and nearly all of the services in the city of Malden.

The influence of meters upon the consumption of water is shown in a comparison of the per capita consumption in the cities and towns where meters are in general use with that of other cities and towns where but few meters have been installed. In Milton, Malden, Watertown and Belmont, where the percentages of meters installed were at the beginning of the year respectively 100, 96.1, 100 and 100, the average per capita rate of consumption in the month of February, the period of greatest consumption, was 36, 44, 53 and 57 gallons. In Revere, Everett, Winthrop and Stoneham, where the general conditions are similar but where the percentages of services metered were at the beginning of the year respectively 5.57, 2.25, 3.37 and 2.25, the average per capita consumption in the same month was respectively 99, 104, 110 and 116 gallons.

The most notable instance of the influence of the introduction of meters is found in the case of the city of Melrose. At the beginning of the year the percentage of services metered was 30.85. By the persistent effort of the city substantially all of the water services had been metered at the end of the year. The daily per

capita consumption was reduced during the year from 118 gallons to 89 gallons, and in the month of December the daily per capita consumption had been reduced to 61 gallons, — a reduction exceeding 47 per cent. as compared with the consumption in December of the previous year.

In the city of Boston the daily per capita rate of consumption during the past year was 158 gallons, and during a continuous period of one month, in which the largest demands were made upon the system, the consumption in that city reached a daily average of 179 gallons per capita. The city of Boston consumes about 78 per cent. of the entire quantity of water furnished, and it is necessary to make provision to supply sufficient quantities of water to meet the requirements for continuous periods of months, if not of weeks, rather than for the entire year.

In this city at the end of the year 1908 there had been installed meters on 5,372 services out of a total of 94,960 in use, being 5.7 per cent. of the whole number of services. Of the 1,177 new services installed in the year only 98 were metered.

It is true that in Boston the quantity of water used for business and manufacturing purposes is large, and the travelling and suburban population from outside the city, which uses the water, is not included in the census population which forms the basis for the rate of consumption. These circumstances, however, do not account for the very great rate of consumption in that city. That there is unnecessary consumption and waste of water is shown from the fact that between the hours of 1 and 4 in the morning the rate of consumption is about 68 per cent. of that for the entire day.

A comparison of the daily use of water in the various districts of the city further shows that the consumption of water for business purposes and by travelling and suburban visitors does not account for the excessive rate of consumption. For instance, in the Brighton high-service district, which is almost entirely residential, the consumption during the month of May last, which was not exceptional, was at the average daily rate of 184 gallons per person, and between the hours of 1 and 4 in the morning the lowest rate on any one day of that month was 127 gallons per person. The daily per capita rate of consumption in that month was in Brighton 184 gallons, and in West Roxbury, also a residential section, was 147 gallons.

The increasing consumption, especially during the two or three months in the year when the greatest demands are made upon the

supply, has become so great as to equal if not to exceed the capacities of the aqueducts, pipe lines and pumping facilities. The Board has repeatedly urged, not only upon the city of Boston but also upon the other cities and towns of the District, the adoption of measures which shall check and prevent, through the introduction of meters and more rigorous inspection, or otherwise, the waste and unnecessary consumption of water which has prevailed to a greater or less extent in the different municipalities. It has been compelled to seek from the present Legislature appropriations, which seem immediately necessary as a matter of safety, for an additional supply main to bring water from the terminus of the Weston Aqueduct at the Charles River, and for additional pumping machinery at Chestnut Hill, at an estimated cost of \$900,000. These additions might have been deferred for a considerable period were it not for the startling increase in recent years in the consumption of water, which has gone far beyond the original calculations made by the State Board of Health of the probable or possible requirements of the District.

The careful investigations which have been made demonstrate, in the opinion of the Board, that at least one-third of the present consumption of the District is not only unnecessary but wasteful. Unless the present rate of consumption is soon largely decreased the time is not far distant when still further works will be required and new sources of supply must be acquired, both much in advance of the time when it was expected that they would be called for.

While the expenditures incurred under the appropriations made for the Metropolitan Water Supply are returned to the State treasury by the municipalities of the Metropolitan District, and the expenditures are ultimately met by the individual water takers through the payment of the water rates, and while the various municipalities are themselves peculiarly called upon to use every effort to postpone as long as possible extensions to the water system, it would seem to be the duty of the Commonwealth to take such action as would tend to prevent unnecessary and wasteful consumption of water, even in justice to the residents of those other districts in the Commonwealth whose lands must be taken and other properties affected in value and whose business interests must be impaired when the exigency arises for taking further sources of water supply.

IX. ELECTROLYSIS.

Investigations have been continued during the year relative to the damages being caused to the water pipes by the electric currents maintained by the street railways where their tracks approach the main pipe lines. Measurements have been made throughout the District of the currents of electricity which have been caused to flow along the various pipe lines, and to further this work, and, if desired, to control the currents, four more insulating joints have been installed.

The investigations show in several places an increasing current of electricity and consequent increasing injury from electrolysis, particularly on the westerly low-service pipe line between the Chestnut Hill Reservoir and the Mystic River, the low-service pipe line between Chestnut Hill Reservoir and the Malden River and the low-service pipe line in Chelsea and Everett.

The 48-inch pipe line in Boylston Street, Cambridge, between the Charles River and Eliot Street, for a distance of nearly 1,000 feet has become so affected that it may become necessary to replace the pipes during the coming year at a considerable expense. It is, of course, difficult in many places to determine the exact condition of the pipes, as this cannot be ascertained without excavating the trenches.

X. LEGISLATION IN THE YEAR 1908.

Acts were passed by the Legislature of the year 1908 making an annual appropriation for the maintenance and operation of the Metropolitan Water System of \$433,000 (chapter 198); and like appropriations for the North Metropolitan Sewerage System of \$146,000 (chapter 211) and for the South Metropolitan Sewerage System of \$105,000 (chapter 213). A special act was also passed to authorize the Board to restore the East Boston sewerage pumping station and to erect other buildings recently damaged and destroyed by fire, and the sum of \$40,000 payable from the maintenance fund was appropriated (chapter 582).

The Board was authorized to expend from the Water Loan Fund in various sums an amount aggregating \$591,500, and further loans were authorized to an amount not exceeding \$398,000 (chapter 558).

The Board was also authorized to construct extensions and additions to the Deer Island and East Boston pumping stations and the total sum of \$445,000 was appropriated, and further loans on account of the North Metropolitan Sewerage System were authorized to the extent of \$413,000 (chapter 556).

By chapter 560 the Board was authorized, upon the application of the town of Swampscott and upon its payment of such sum as the Board might fix, to include the town in the Metropolitan Water District, and to furnish it with water under the terms prescribed by the Metropolitan Water Act.

XI. RECOMMENDATIONS FOR ADDITIONAL WATER AND SEWERAGE LOANS.

The Board, in its abstract of the annual report to the Legislature at the beginning of the session of the year 1909, made the following statements and recommendations regarding additional water loans for necessary construction for the coming year and the discharge of liabilities already accrued and existing:—

“ It appears from the foregoing financial statement that on December 1, 1908, the balance remaining unexpended on account of the amount of the Metropolitan Water Loan Fund, authorized for the construction and acquisition of works, was \$393,141.13.

“ The Legislature of last year authorized expenditures on account of the Metropolitan Water Works as follows: for a power plant at the Wachusett Dam, a sum not exceeding \$115,000; for concrete walls and tile floor at the gate and power house at Wachusett Dam, a sum not exceeding \$7,000; for a new 48-inch main from Chestnut Hill Reservoir to the Boston city line, a sum not exceeding \$190,000; for the completion of the Arlington pumping station and its equipment, a sum not exceeding \$14,500; for the construction of sewers, cesspools and other improvements necessary on the watershed of the Wachusett Reservoir, a sum not exceeding \$5,000; for settlement of suits now pending in the courts and for claims and reserves payable on completed contracts, a sum not exceeding \$260,000, making a total of \$591,500.

“ The work of laying the new 48-inch main from Chestnut Hill Reservoir has been begun, and the sum of \$53,009.26 has been so far expended upon it; the sum of \$9,453.03 has been expended

toward the completion of the Arlington pumping station; and the sum of \$2,837.88 has been thus far spent upon improvements on the watershed of the Wachusett Reservoir. The sum of \$114,033.54 has been expended in the settlement of suits and claims and the payment of balances due on uncompleted contracts. There was also expended, in connection with the Wachusett Dam and Reservoir, the Weston Aqueduct, the Distribution System and for the completion of other minor works, the sum of \$27,083.62.

“It is expected that all the work begun under the above-named appropriations of last year will be completed within the amounts allowed; and, inasmuch as some of the most important suits have been settled for less than the amounts claimed, it is estimated that the balance of the appropriation made for this purpose will be more than sufficient to meet the suits and claims still remaining unsettled.

“No work has been undertaken under the appropriation for a power plant at Wachusett Dam and for the walls and floor of the power house, for which payments of \$115,000 and \$7,000 were respectively authorized. The construction of the power plant and the laying of the floor in the power house have necessarily been postponed to await a determination in negotiations which have been pending with the officials of the town of Clinton for the disposal of the power to be generated, and for fixing the valuation of the plant for purposes of taxation.

“In addition to completing the work already authorized, it is deemed necessary by the Board to continue, in accordance with the requirements of the original Metropolitan Water Act, measures for removing from the watersheds the more threatening sources of pollution and for the purification of the water supplied to the District. Much of this work, in order to be accomplished economically, must be carried out when the favorable opportunities occur, or must be undertaken when the emergencies arise. It is recommended that the expenditure of \$15,000, in addition to the balance of last year's appropriation, be authorized for this purpose.

“There should also be sums available for small extensions of the Distribution System, which are from time to time called for, for furnishing supplies of water to the various portions of the Metropolitan District in the quantities or at the pressures required under their changing circumstances. For this purpose it is recommended that authority be given to expend a sum not exceeding \$10,000.

“It has become necessary to construct a new main for supplying water to the town of Winthrop. So long as water was furnished for the supply of the towns of Revere and Winthrop through the Revere Water Company, the water for both towns was delivered to the Company at a point in the town of Revere. The town of Revere has now, however, acquired the property of the Water Company, and water is furnished by the Metropolitan Works directly to the two towns. The town of Revere, consequently, owns a small portion of the pipe line through which the Metropolitan supply is furnished to the town of Winthrop. The Metropolitan Water Act requires the Board to supply each city and town by delivering the water into a main pipe or reservoir of the city or town; and now, inasmuch as the town of Revere is about to require the old main for its own purposes, it will be necessary to supply the place of the town's main by a new main, at an estimated expense of \$14,500.

“There is the balance of \$393,141.13 remaining still unexpended for which loans have been authorized, which will cover all sums required to complete the operations already undertaken under last year's appropriations, to construct and equip the power plant and finish the power house at the Wachusett Dam, to satisfy unsettled suits and claims, and, in addition, to provide for the proposed appropriations above recommended for the ordinary or necessary operations of the Board.

“There are some larger needs of the District, to which the Board is compelled in the present year to call the attention of the Legislature. The increasing consumption of water in the District necessitates, in its judgment, the beginning of the construction of some additional works of distribution of the water supply which it has been hoped might be postponed for some years to come.

“The present trouble arises not from the lack of water in storage, but from the want of sufficient means to bring the necessary supply of water from the storage reservoirs into the District. The water in the Wachusett and Sudbury reservoirs, the main sources of supply, is brought into the District by the Sudbury and Weston aqueducts. The Sudbury Aqueduct is capable of bringing 100,000,000 gallons of water per day to the Chestnut Hill Reservoir and pumping stations. The new Weston Aqueduct is built with a capacity of 300,000,000 gallons per day, and extends from the Sudbury Reservoir only as far as the Charles River. From this terminal point

of the aqueduct a single main pipe line with a capacity of 30,000,000 gallons per day has thus far been laid into the District, and it is in accordance with the original scheme that additional mains shall be laid from this terminus into the District from time to time as they shall be required.

“ The other source of supply is Lake Cochituate, from which water is brought by the Cochituate Aqueduct, having a capacity when in use of 20,000,000 gallons daily.

“ The possible maximum capacity, therefore, of all the aqueducts and the pipe line for bringing water into the District is 150,000,000 gallons per day; but this maximum is for considerable periods reduced to 130,000,000 gallons, because there are times, particularly in the winter season, when the consumption is the greatest, when the Cochituate water is unsuitable for drinking purposes and is shut off.

“ The consumption of water in the District, which is constantly increasing, has at times already become so great as to equal if not to exceed the present capacity of all the aqueducts and pipe line, so as to compel at times the drawing down of the distributing reservoirs within the District. The present average daily demand for consumption is 128,000,000 gallons, but during continuous periods of two or three months in the winter the average daily consumption reaches 140,000,000 gallons, and it is estimated that by the time a new pipe line can be placed in operation such consumption will reach a daily rate of 154,000,000 gallons. Allowing, however, even for a very moderate increase in the present consumption, the present facilities for furnishing water to the various portions of the District will, by the time the new works can be constructed and put into operation, be severely taxed.

“ The Board believes it wiser and more economical to lay a 60-inch main instead of a 48-inch main; and it accordingly recommends that authority be given to lay such a main from the terminus of the Weston Aqueduct at Charles River to make connection with the present mains near Chestnut Hill Reservoir, a distance of about 7 miles, at an estimated cost of \$750,000. Such a main will have a daily capacity of 47,000,000 gallons.

“ For like reasons the Board deems that it has become necessary to provide an additional pumping engine for the high service at the Chestnut Hill pumping station. Arrangements were made two years

ago for the utilization of the low-service station, in order temporarily to provide for emergencies which might arise in the high service. The called-for extensions of the high service, as well as the increasing consumption, are making such demands upon the pumping service that the Board is compelled to believe that it is unsafe to put off longer the installation of an additional pumping engine for the high service.

“ The Chestnut Hill high-service station has at present one engine having a capacity for pumping 30,000,000 gallons daily, and three small engines having a combined daily capacity of 36,000,000 gallons. There are periods when the large engine (as well as the smaller engines) will by accident or otherwise be put out of service, and in such times the total daily pumping capacity of the station is reduced to 36,000,000 gallons. The present consumption of the district supplied is nearly 38,000,000 gallons daily, and for certain continuous periods it now reaches 44,000,000 gallons per day. It is estimated that by the time an additional engine can be installed the average daily consumption of this district will reach 46,500,000 gallons, and that the consumption for considerable periods will require the daily pumping of 52,500,000 gallons.

“ The Board recommends that authority be given to contract for the construction of a new engine, having a daily capacity of 30,000,000 gallons, at an estimated expense of \$150,000.

“ An act was passed by the last Legislature permitting the admission of the town of Swampscott into the Metropolitan Water District. The town has been supplied with water from the Metropolitan District for the past ten years, under a contract which has just expired. The furnishing of water to that town and to the town of Nahant, which was admitted into the District, necessitated supplying water to these towns through the main which was originally designed and used only for the municipalities of Everett, Chelsea, Revere and Winthrop. The large increase in the consumption of all these cities and towns has had the effect, at times of great demand, seriously to decrease the pressure in both Nahant and Swampscott, which are now situated at the end of the pipe line. If the town of Swampscott shall be admitted into the Metropolitan Water District, as is now proposed, it will be necessary to lay an additional main in Everett, Chelsea and Revere, for a distance of a little over 2 miles, at an estimated cost of \$68,000.

“The Board accordingly recommends that, in addition to completing the works and making the expenditures authorized by the Legislature of last year, it be empowered to expend: for the protection and purification of the waters of the Wachusett watershed, a sum not exceeding \$15,000; for making small extensions of the Distribution System, a sum not exceeding \$10,000; and for constructing a new main for the town of Winthrop, a sum not exceeding \$14,500, — for all which the loans already authorized will be sufficient.

“The Board also recommends that authority be given to make expenditures for the following works: —

For laying a water main from the terminus of the Weston Aqueduct to a connection near the Chestnut Hill Reservoir, a sum not exceeding	\$750,000
For an additional pumping engine for the high service at the Chestnut Hill pumping station, a sum not exceeding	150,000
For laying a new main in Everett, Chelsea and Revere, a sum not exceeding	68,000
Total,	<u>\$968,000</u>

“For accomplishing these purposes, authority will be required for issuing additional Metropolitan Water Loans to the amount of \$968,000.”

It was also suggested that legislation should be adopted for the protection of the distributing reservoirs from the large numbers of gulls and ducks which make especially Spot Pond and the Chestnut Hill Reservoir their resort, as follows: —

“Much complaint has been made to the Board from time to time regarding the numbers of gulls and wild ducks which resort, particularly in the spring and autumn months of the year, to the distributing reservoirs in the Metropolitan District. The trouble arises principally at Spot Pond, where the number of these birds has on a single day reached apparently as many as 2,000. The gulls are found in rather larger numbers than the ducks.

“The presence of these birds causes an offensive condition at the points in the pond where they particularly congregate, which tends to pollute the water, and they are certainly a menace to the public health.

“Various means have been taken to drive the birds from the pond. Blank cartridges have been fired to a very considerable extent, both

from the shores and from boats, but the relief has been only temporary, particularly in the case of the gulls. It would seem that the gulls especially, though at first frightened, have quickly learned to recognize that the shooting is harmless. It is possible that if provision should be made to enable the Board to provide and man a motor boat, which should frequently patrol the pond, the birds might be kept away from the pond; but the experiments which have been made indicate that such a patrol would not prove effective in driving away the gulls, at least.

“Under the statutes of the Commonwealth gulls and certain kinds of ducks are protected throughout the year, while other ducks are protected during a portion of the year.

“The Board suggests that some employés of the Board, specially authorized thereto, be empowered under proper regulations to shoot gulls and ducks when resorting in considerable numbers to the distributing reservoirs of the Metropolitan Water Works, so that, in case other methods fail, this means of relief may be adopted for the protection of the water supply.”

Bills have also been introduced, at the instance of the Board, first, to define more clearly the law regarding annual payments in lieu of taxes to cities and towns in which lands are held for water-supply purposes, and second, to authorize the Board to furnish water for the supply of sections of cities and towns in which the water-pipe system is owned by a city or town within the Metropolitan Water District.

No new appropriations for the Sewerage Works were called for, but report was made concerning the expenditures for the enlargement of the Deer Island and East Boston pumping stations and the High-level Sewer extension.

“The Board was authorized by the Legislature of the year 1908 to proceed in the North Metropolitan System upon the enlargement of the East Boston and Deer Island pumping stations and the installation of new engines and pumps, and for these purposes was authorized to expend in the years 1908, 1909 and 1910 the sums of \$250,000 and \$195,000 respectively.

“The work of enlarging the Deer Island station has been begun, and a contract has been awarded for the building of the new engine and boilers for the station. There was expended on account of this enlargement, during the past fiscal year, the sum of \$17,342.59.

“ The great fire in Chelsea, which occurred in April of last year, caused the partial destruction of the East Boston pumping station, and the total destruction of the stable, locker and other buildings connected with it. It was necessary to repair the station and the pumping engines with the greatest possible expedition, in order that the interruption in sewage disposal should not injuriously affect the health of that portion of the District. For this purpose a special appropriation of \$40,000 was provided, which was made chargeable to maintenance. The occurrence of the fire, however, induced the Board to defer for a time the construction of the enlargement of the station, and to enter upon a careful investigation as to the future requirements of the North Metropolitan System. It has finally been determined advisable to proceed as contemplated with the plan of enlarging the station originally adopted. The work upon these two pumping stations does not call for any further appropriations.

“ The land in East Boston on which the stable and locker buildings had been erected was sold for the sum of \$17,500. The Board was authorized by the last Legislature to use the money received from this sale for the purchase of land and the erection of stable and locker buildings thereon, and this sum is believed to be sufficient for the purpose.

“ The Legislature of the year 1906 made provision for the extension of the High-level Sewer in the South Metropolitan System through portions of Boston and Brookline, for which an appropriation of \$1,175,000 was made. The work of constructing this extension has been continued during the past year with an expenditure of \$567,-865.15; and will probably be completed by the middle of the current year. The construction of the extension of the High-level Sewer will be accomplished within the amount appropriated.”

XII. FUTURE WORK.

The maintenance and operation, for the year 1909, of the various works for the water supply and distribution of water in the cities and towns in the Metropolitan Water District, and of the works constructed for the collection and disposal of the sewage in the various cities and towns in the North and South Metropolitan Sewerage districts, will require, according to the estimates given to the State Auditor, a total expenditure of \$699,100. The Board

has included in this amount the sum of \$30,000, which it deems necessary to expend in order to carry on the improvements which have been made in the Snake Brook branch of Lake Cochituate. It is proposed to divert the street washings and other overflows in the village of Cochituate and the contents of a small brook which flows through the village, so that they shall not be discharged into the lake or any of its tributaries.

The laying of the new 48-inch main from Chestnut Hill to the boundary line between the town of Brookline and the city of Boston, in order to reinforce the water supply of that city, will be continued and finished within the year.

The increasing consumption of water in the District has compelled the Board to ask for authority to construct a second main from the terminus of the Weston Aqueduct into the District, and, if authority is granted, the Board will proceed to lay a 60-inch main line for a distance of about seven miles, and will also proceed to have built a new pumping engine having a daily capacity of 30,000,000 gallons, to be installed at Chestnut Hill for the high service.

It is probable that the town of Swampscott will seek admission into the Metropolitan Water District in accordance with the terms of the act which was passed by the Legislature of last year. In case the town shall be admitted into the District, or even in case the contract for supplying water to that town, which has just expired, shall be renewed, it will be necessary to lay an additional main in Everett, Chelsea and Revere for a distance of a little over two miles.

To fulfil the requirements of the Metropolitan Water Act the Board will be obliged in the coming year to lay a new main in the town of Winthrop, for a length of about three-quarters of a mile, to take the place of an old main now belonging to the town of Revere, and which is required by that town for its own purposes.

Extensions of the distribution system become necessary each year in order to provide for the new connections which are made in different localities of the District. The request has very recently been made for an extension of the high-service mains in the town of Belmont to a section of that town which the town is about to provide with a water supply, and similar necessities are from time to time arising in the different parts of the District.

The Board will also be expected to continue the policy originally called for by the report of the State Board of Health in 1895, of

gradually removing the more threatening sources of pollution and pursuing measures for the purification of the water supply.

The installation of a power plant at the Wachusett Dam has been deferred to await the determination of the town of Clinton regarding the valuation for taxation of the proposed plant and the disposal of the power which may be produced.

There still remain for settlement and adjustment suits and claims for a considerable amount on account of the construction and acquisition of works.

The extension of the High-level Sewer from its connection at Jamaica Plain with the main sewer to a point near the boundary line in Brighton and Newton will be completed early in the current year.

The work which is already begun will be continued upon the enlargement of the Deer Island pumping station in the North Metropolitan District, and it is expected that a corresponding enlargement of the East Boston pumping station will be entered upon early in the year.

The Board has been making, through its engineers, investigations of the future needs of the North Metropolitan System, in which, during the twenty years since it was established, there has been much increase of population and business. Some of the lines of sewers, notably the Mystic valley main sewer, are approaching the limits of their capacities, and it is anticipated that the question of the future provision for that System will be brought under the consideration of the Board during the current year.

The detailed reports of the Chief Engineer of the Water Works and of the Chief Engineer of the Sewerage Works, with various tables and statistics, are herewith presented.

Respectfully submitted,

HENRY H. SPRAGUE.
HENRY P. WALCOTT.
JAMES A. BAILEY, JR.

REPORT OF CHIEF ENGINEER OF WATER WORKS.

To the Metropolitan Water and Sewerage Board.

GENTLEMEN: — The following is a report of the work under the charge of the Chief Engineer of the Metropolitan Water Works for the year ending December 31, 1908.

GENERAL STATEMENT.

The work under the charge of the Chief Engineer includes not only the construction of new works but also the maintenance and operation of the works; and as the construction work, which was begun in 1895, was practically finished in 1906, the work at present is principally connected with the maintenance and operation of works already built. There has been, however, some construction work in progress during the past year, the principal items of which are a new 48-inch main for increasing the supply of water in the Boston low-service district, an extension of a 16-inch supply main in Arlington, the construction of stop-planks and fence at the overflow of the Wachusett Dam, the removal of soil from the Wachusett Reservoir and the completion and testing of the pumping engines at the new Arlington station.

ORGANIZATION.

The position of Superintendent of Pipe Lines and Reservoirs in the Distribution Department was made vacant on July 17 by the death of George E. Wilde, who had held the office since the works were first operated, on January 1, 1898. Samuel E. Killam, who had previously been employed in the engineering force, was promoted to fill the position made vacant by Mr. Wilde's death.

The principal assistants employed under the direction of the Chief Engineer at the close of the year were as follows: —

- Elliot R. B. Allardice, *Superintendent, Wachusett Department.*
- Charles E. Haberstroh, *Superintendent, Sudbury Department.*
- Samuel E. Killam, . *Superintendent, Pipe Lines and Reservoirs, Dis-*
tribution Department.
- Arthur E. O'Neil, . *Superintendent, Pumping Stations, Distribution De-*
partment.
- William E. Foss, . *Division Engineer, specially in charge of electrolytic*
investigations and pipe laying.
- Alfred O. Doane, . *Division Engineer, specially in charge of engineering*
work at pumping stations.
- Benjamin F. Hancox, *Assistant in charge of Drafting Department.*
- William E. Whittaker, *Office Assistant.*
- Arthur W. Walker, . *Biologist.*
- William W. Locke, . *Sanitary Inspector.*

At the beginning of the year the engineering force, including those engaged upon both the construction and maintenance of the works, numbered 45, and at the end of the year 40.

There has also been a maintenance force, exclusive of the engineers above mentioned, averaging 251, employed in the operation of the several pumping stations and in connection with the maintenance of the reservoirs, aqueducts and pipe lines, and in doing minor construction work.

The number of men employed in the several departments has been as follows: —

	Beginning of Year.	End of Year.	Average.
Wachusett Department,	48	40	56
Sudbury Department,	46	62	61
Distribution Department, Pipe Lines and Reservoirs, . . .	66	70	72
Distribution Department, Pumping Service,	58	61	62
	218	233	251

CONSTRUCTION.

WACHUSETT RESERVOIR AND DAM.

Soil Stripping.

Additional clearing and grubbing and the removal of soil have been necessary at a number of points along the south shore of the reservoir between the southerly end of the South Dike in Boylston and Worcester Street in West Boylston, also along the north shore

at Kendall Cove and Thomas Basin. This work was due to the caving away of the banks beyond the limits of the original soil stripping or of the additional soil stripping done in the previous year. The soil has been stripped for an aggregate length of 12,240 feet of shore line, for a width varying from 5 to 50 feet, the aggregate area being 3.43 acres. The total cost of doing this work was \$1,685.45.

Work at Wachusett Dam.

All of the stop-planks required for use on the waste-weir of the dam have been made. They are of hard pine, 9 feet 11 inches long, 6 inches deep, fitted with a drop-forged steel hook at each end for use in placing and removing the planks. One hundred and twenty of the planks, for use on the low-level portion of the waste-way, are 6 inches thick at the centre, tapering to 4 inches at either end where they enter the grooves. The balance, 330 in number, are 4 inches thick for their entire length. They were made by the maintenance force at a cost, including material, of \$1,992.20.

An industrial railway track with a gage of 21½ inches has been laid on the bridge over the waste-weir, and a small hand car has been made for use in transporting the stop-planks from the storage room in the bastion chamber to the waste-weir.

A 1½-inch pipe-rail fence with 2-inch posts 3 feet high has been erected on the up-stream side of the waste-weir bridge for its entire length, for the protection of the men employed in placing or removing the stop-planks.

At the close of 1907 the work of filling and pointing with Portland cement mortar the expansion cracks in the joints of the ashlar facing of the up-stream face of the dam had been completed to elevation 384. This work was continued to elevation 405, or 10 feet above full-reservoir level, during the early portion of the year.

Improvement of Watershed.

The dams at the sites of the Tietze Mills in Holden, and the Henry E. Stone Mill in Sterling, have been torn down so as to drain the old mill-ponds; the buildings on the properties have been removed, cellar holes graded and the grounds cleaned, so as to leave them in a neat and sanitary condition.

Three 1½-story dwelling houses on property formerly owned by C. L. Bates in Clinton, a 1½-story dwelling house and barn on

property formerly owned by M. W. Houghton in West Boylston, and an ice house and store house on the Gates property in Sterling, have been torn down and the premises cleared and graded.

Cesspools and diverting ditches have been built on the property of A. A. Wilson in West Boylston, and on the C. E. Boyle estate in Sterling, in order to prevent objectionable drainage from entering the brooks tributary to the Wachusett Reservoir.

NEW 48-INCH SUPPLY MAIN FOR THE BOSTON LOW-SERVICE DISTRICT.

An act authorizing the expenditure of \$190,000 for laying an additional 48-inch main from a point near Chestnut Hill Reservoir through Beacon Street, Harvard Street and Longwood Avenue to the Boston line, was approved on May 29, 1908. On August 1 a contract was made with the Warren Foundry and Machine Company of Phillipsburgh, N. J., for furnishing 4,100 tons of 48-inch pipe, 60 tons of 36-inch pipe and 130 tons of special castings required for the work; on August 26 a contract was made with the Coffin Valve Company of Boston for supplying 10 36-inch and 8 12-inch valves, and on September 5 a contract was made with Bruno & Petitti of Boston for laying the pipes. The work of laying the pipes was begun on September 16, and on December 6 the portion of the pipe line extending from the Riverway, near Longwood Avenue, in Boston, to Coolidge Corner in Brookline, a distance of 3,471 feet, had been laid and connected with a 48-inch main belonging to the city of Boston, so that this portion of the new line can be placed in service as soon as the city completes the work of extending the main from the Riverway to Brookline Avenue. Work will be resumed as soon as the frost leaves the ground, and it is expected that the main will be completed to Chestnut Hill Reservoir on August 1, 1909. The amount expended on account of the work to December 31 was \$64,569.27.

ARLINGTON PUMPING STATION.

At the beginning of the year the pumping station building was completed, one engine and two boilers installed and in operation, and a second engine completed in the shops of the Blake & Knowles Steam Pump Works, ready to be placed in position. This engine was delivered, erected and the necessary steam and water connec-



MAKING CONNECTION BETWEEN NEW 48-INCH MAIN AND BOSTON WATER
WORKS MAIN IN BEACON STREET, BROOKLINE.

tions made during the month of January, and was first operated on February 8. It is of the horizontal, duplex, compound, condensing, direct-acting type, with outside packed plungers. The steam cylinders are 11 inches and 22 inches in diameter and are jacketed on both heads and barrels. The pump plungers are 12 inches in diameter, and both steam pistons and water plungers have a stroke of 18 inches. There is a Worthington condenser in the suction main near the engine, with a cooling surface of 250 square feet, and connected with the exhaust steam pipes a feed-water heater fitted with a brass pipe coil, giving 26 square feet of heating surface. The condensed steam is pumped by an independent air pump of the Blake single-acting horizontal type, having 5½-inch steam cylinder, 8-inch water cylinder and 7-inch stroke.

The water pumped at this station is taken under pressure from a 20-inch low-service main, and the pressure on the suction side of the pumps is about 23.5 pounds. The contract for this engine stipulated that it should have a capacity of 1,500,000 gallons in twenty-four hours, with a piston speed of not over 95 feet per minute. The duty guaranteed was 50,000,000 foot-pounds per 1,000 pounds of steam when pumping against a total head of 290 feet with a steam pressure not exceeding 125 pounds per square inch. The final test of the engine was made on May 25 and 26, with the following results:—

Duration of trial (hours),	24
Average head pumped against (feet),	290.12
Plunger speed (feet per minute),	95.825
Total quantity pumped:—	
Basis of plunger displacement (gallons),	1,578,865
Measured by Venturi meter (gallons),	1,551,400
Steam used by engine, jackets and air pump (pounds),	62,853.5
Duty per 1,000 pounds dry steam (foot pounds),	60,727,400
Duty per 100 pounds of moist coal (foot-pounds),	52,122,480
Evaporation of boiler per pound of moist coal from and at 212° F. (pounds),	9.821

The engine furnished by the Allis-Chalmers Company was erected in 1907 and has been in almost constant use during the past year. The official duty trials, however, were delayed for various reasons, and the final tests were not completed until January 7, 1909. This engine is of the horizontal, cross-compound, fly-wheel type, fitted

with Corliss valve gear, and operates two horizontal, outside-packed plunger pumps. The high and low pressure steam pistons are 14 inches and 28 inches in diameter, respectively, and the pump plungers 8½ inches in diameter, all having a stroke of 18 inches. The contract stipulated that the engine should have a capacity of 1,500,000 gallons in twenty-four hours when operated at a plunger speed of 195 feet per minute against a head of 290 feet, and when operated at that rate should show a duty of 120,000,000 foot-pounds per 1,000 pounds of dry steam; also, that when pumping at the rate of 750,000 gallons in twenty-four hours the engine should show a duty of 110,000,000 foot-pounds per 1,000 pounds of steam, the engine to be supplied with steam under a pressure of 125 pounds per square inch. The contract also provided for a bonus of \$100 or a penalty of \$200 for each 1,000,000 foot-pounds excess or deficiency, as compared with the guaranteed duty. The results of the trials of this engine were as follows:—

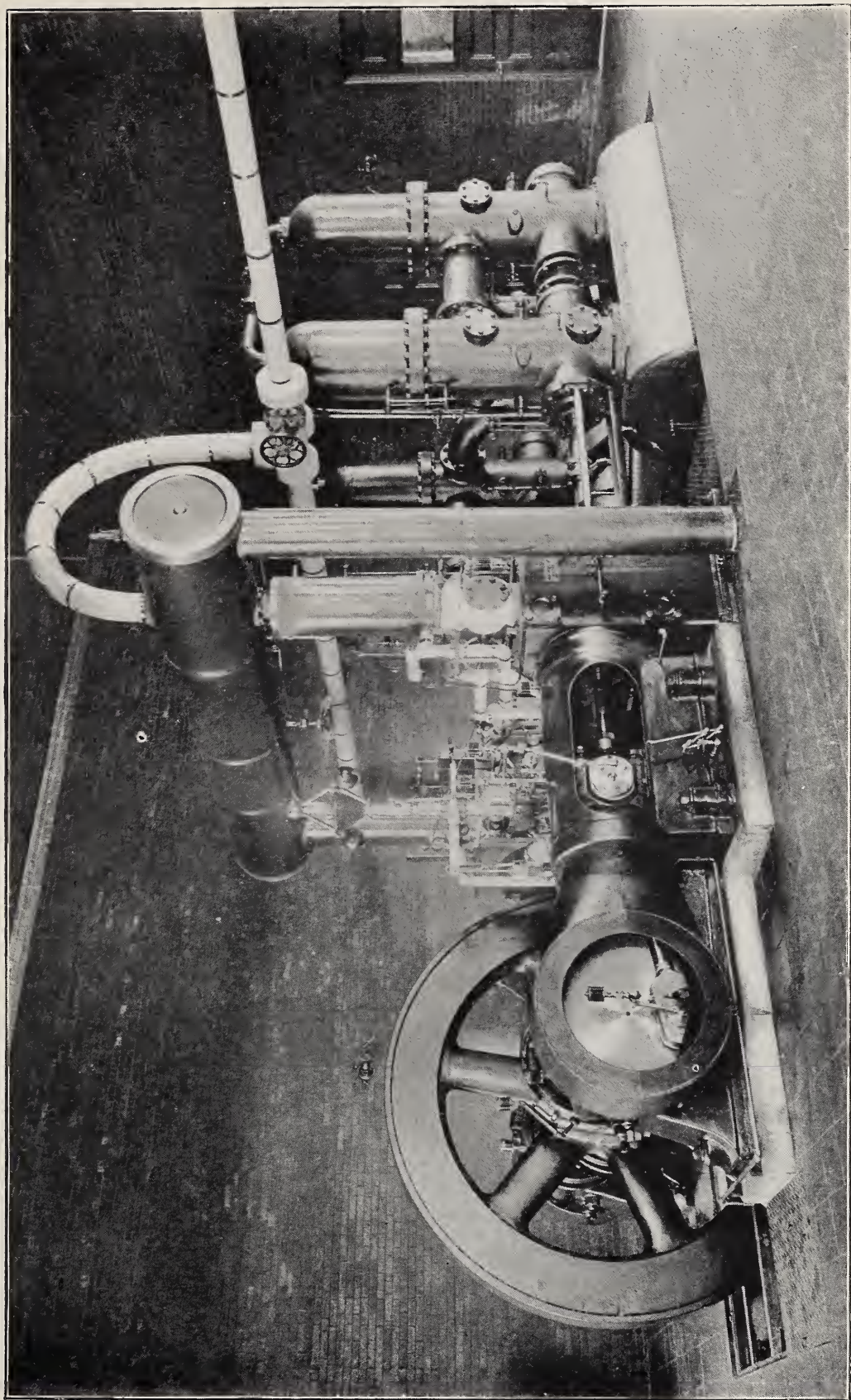
One-half Capacity Trial, made December 31, 1908–January 1, 1909.

Duration of trial (hours),	24
Average head pumped against (feet),	290.11
Plunger speed (feet per minute),	95.905
Total quantity pumped:—	
Basis of plunger displacement (gallons),	771,360
Measured by Venturi meter (gallons),	763,525
Steam used by engine, jackets and air pump (pounds),	17,671
Duty per 1,000 pounds of dry steam (foot-pounds),	106,742,470

Full Capacity Trial, January 6–7, 1909.

Duration of trial (hours),	24
Average head pumped against (feet),	290.3
Plunger speed (feet per minute),	191.346
Total quantity pumped:—	
Basis of plunger displacement (gallons),	1,538,977
Measured by Venturi meter (gallons),	1,530,986
Steam used by engine, jackets and air pump (pounds),	32,475
Duty per 1,000 pounds dry steam (foot-pounds),	115,959,370
Duty per 100 pounds of moist coal (foot-pounds),	90,025,832
Evaporation of boiler per pound of moist coal from and at 212° F. (pounds),	9.77

The duty developed by the engine on both trials was less than guaranteed, and there will be deducted from the contract price, in accordance with the terms of the contract, the sum of \$1,459.63.



NEW ENGINE AT ARLINGTON PUMPING STATION.

Other work done at this station has been the construction of a cast-iron floor around the Allis-Chalmers engine, furnished by the G. W. and F. Smith Iron Company of Boston, and erected by the regular employés of the station. The steam piping in connection with the Blake engine and the tops of the boilers were covered with non-conducting covering by the C. W. Trainer Manufacturing Company. An electric indicator has been installed for the purpose of indicating high and low water mark in the Arlington standpipe. The grounds about the station have been graded, seeded and planted with shrubbery.

The principal items of cost of this station, exclusive of engineering, are as follows:—

Building, including chimney and engine and boiler foundations,	\$33,208 12
Engines,	14,233 43
Boilers and setting,	6,156 38
Piping for engines, boilers, heating, etc.,	2,859 31
Railroad side track,	840 76
Miscellaneous, including laying of suction and delivery pipes, grading grounds and other work,	3,110 31
	<hr/>
	\$60,408 31

EXTENSION OF MAINS.

The 16-inch high-service main in Massachusetts Avenue in Arlington has been extended from Brattle Street to Robbins Road, a distance of 421 feet, and connected with the 6-inch pipe in Robbins Road, at a cost of \$1,202.49. A 6-inch Venturi meter has been installed at Beachmont Square in Revere, at a cost, including the meter register, insulated chamber and necessary connections, of \$996.33.

ENGINEERING.

Preliminary plans and estimates have been made for a 60-inch pipe line from the present terminus of the 60-inch line leading from the Weston Aqueduct, near the Charles River, through the city of Newton and a portion of the Brighton district to Beacon Street, near Chestnut Hill Reservoir.

Surveys, plans and estimates have been made for improving the channel of the Stillwater River for about 1.4 miles, and for draining about 200 acres of adjacent swamp land in the town of Sterling.

Record plans have been made showing the property owned by the

Commonwealth in connection with the Wachusett Reservoir and Aqueduct, of the Crane swamp property in Westborough with the location of swamp ditches, of swamps Nos. 54, 55 and 56 in Holden and Princeton showing the location of ditches, of the Wachusett Dam, of masonry highway bridges over the Stillwater and Quinepoxet rivers at Oakdale, and of the Sterling filter-beds.

Investigations and estimates have been made for additional pipe lines in West Roxbury, Hyde Park, Winthrop, Everett, Chelsea and Revere.

MAINTENANCE.

RAINFALL AND YIELD.

The rainfall for the year on all of the watersheds has been very much below the average. On the Sudbury watershed it was 36.15 inches, or 9.55 inches below the average for thirty-four years, and, with the exception of the year 1883, the lowest during the whole period. On the Wachusett watershed the total rainfall for the year was 37.83 inches, or 10.23 inches below the average of the past twelve years. During the first five months of the year the yield of the Wachusett watershed was but little below the average, but for the last seven months the yield was 25 per cent. less than for the same period during any one of the past twelve years, and the yield for the year was 29 per cent. less than the average for that period.

Statistics relating to rainfall and yield of watersheds may be found in Appendix No. 2, tables 1 to 11.

STORAGE RESERVOIRS.

The quantity of water stored in all of the storage reservoirs on January 1, 1908, was 65,856,900,000 gallons. During the first eighteen days of the month of January there was a gain of 4,206,000,000 gallons in the quantity stored. From January 18 to February 10 there was very little gain in storage, but between the latter date and March 30 there was a gain of 8,115,000,000 gallons. All of the storage reservoirs were practically full from May 15 until June 1. On account of the low rainfall during the last seven months of the year there was an almost continual loss of storage from June 1 to January 1, 1909, amounting to 21,547,000,000 gallons. The quantity stored on January 1, 1909, was 6,966,600,000 gallons less than at the beginning of the year.

The following table gives the quantity of water stored in the storage reservoirs at the beginning of each month:—

Quantity of Water stored in Wachusett Reservoir, and in Reservoirs on Sudbury and Cochituate Watersheds, at the Beginning of Each Month.

DATE.	In Wachusett Reservoir (Gallons).	In Sudbury Reservoir and Framingham Reservoir No. 3 (Gallons).	In All Other Storage Reservoirs (Gallons).	Total (Gallons).
1908.				
January 1,	51,267,000,000	7,944,700,000	6,645,200,000	65,856,900,000
February 1,	56,378,100,000	7,114,600,000	6,970,300,000	70,463,000,000
March 1,	59,337,400,000	7,434,200,000	6,726,100,000	73,497,700,000
April 1,	63,345,400,000	8,090,600,000	6,835,900,000	78,271,900,000
May 1,	64,040,600,000	8,044,700,000	6,910,800,000	78,996,100,000
June 1,	65,197,200,000	8,115,200,000	7,124,900,000	80,437,300,000
July 1,	62,852,500,000	7,881,000,000	6,869,600,000	77,603,100,000
August 1,	59,428,600,000	7,963,500,000	6,600,000,000	73,992,100,000
September 1,	57,092,800,000	7,924,800,000	6,557,500,000	71,575,100,000
October 1,	53,360,500,000	7,973,100,000	6,419,900,000	67,753,500,000
November 1,	51,018,300,000	6,939,800,000	6,485,600,000	64,493,700,000
December 1,	50,298,800,000	4,820,700,000	6,132,100,000	61,251,600,000
1909.				
January 1,	46,176,000,000	6,495,300,000	6,219,000,000	58,890,300,000

Wachusett Reservoir and Dam.—At the beginning of the year the water in this reservoir was at elevation 384.31 and the reservoir contained 51,267,000,000 gallons. There was a continuous rise in the elevation of the surface of the reservoir until March 28, at which time the water stood at elevation 393.83, or 1.17 feet below the normal full-reservoir level. It was held at this elevation until the first of May, when it was allowed to rise and reached elevation 395 on May 10. The highest elevation of the reservoir was 395.31, at 11 P.M. on May 30. After the latter date and up to the close of the year there was an almost continual fall in the elevation of the water in the reservoir, and on January 1, 1909, it stood at elevation 379.87 and contained 46,176,000,000 gallons, showing a net loss for the entire year of 5,091,000,000 gallons.

Water was wasted over the waste-weir on sixteen days between March 28 and June 2, the total quantity wasted being 1,705,900,000 gallons. The maximum rate of flow over the waste-weir

was on May 31, when for several hours it reached a rate of 688,800,000 gallons per twenty-four hours.

The average daily quantity supplied to the Lancaster Mills during the year was 2,767,000 gallons.

The work of repairing and reinforcing the North Dike was nearly finished in 1907, and was fully described in the report for that year. The Hugh Nawn Contracting Company placed about 600 cubic yards of riprap on the slope of the dike between January 1 and 14, completing its contract. As soon as the weather permitted the final grading and seeding of the repaired portion of the dike were done by the day-labor force. The total cost of repairing the damage done by the slide, together with the cost of reinforcing the dike, was \$57,950.82.

For the purpose of observing the elevation of the ground water in the different portions of the dike, four additional pipe wells 2 inches in diameter have been driven through the filled portion of the dike into the underlying sand, and for the purpose of obtaining a measurement of the quantity percolating through the dike a culvert through the embankment dividing Coachlace Pond has been lowered and measuring weirs have been established.

About 29.4 acres of land on the back slopes of the North Dike have been plowed and sowed with grass seed, and 10 acres of grass land on the South Dike have been top-dressed with sludge from the settling tanks at the Clinton sewerage filter-beds.

The final clearing of the reservoir bottom above elevation 385, done in 1907, was of necessity not as thoroughly done as that below this elevation, on account of the rapidly rising waters of the reservoir and the setting in of freezing weather. Over the greater part of the area between elevations 385 and 398 the ground has been gone over during the past year, the weeds, bushes and roots pulled and the refuse either burned or carted outside the limits of the reservoir. There were cleaned in this manner a total of 333 acres, at a cost of \$2,221.14.

The shore at the easterly end of the reservoir, beginning at a point 500 feet south of the Wachusett Dam, and extending for a distance of 1,250 feet, was originally covered with cobble stones for a width of about 20 feet and to a depth of about 9 inches. When the reservoir was full this protection proved insufficient, and it has

been reinforced with riprap about 3 feet in thickness at the high-water line. This work cost \$802.87.

At three points where highway embankments form the shore line the wave action caused the original ground to cave away at the ends of the slope paving and it has been necessary to protect the embankments with riprap at these points.

Through the upper end of the reservoir at Oakdale the Worcester, Nashua & Portland Division of the Boston & Maine Railroad passes for about 4,800 feet on an embankment having a maximum height of about 23 feet, with the finished grade about 5 feet above full reservoir level. The embankment gradually settled as the water rose in the reservoir, the maximum settlement amounting to about 6 inches. The work of restoring this embankment and tracks to grade has been done by employes of the Boston & Maine Railroad, the expense to be borne by the Commonwealth.

There have been placed in the reservoir 21 spar buoys, to mark dangerous shoals and points.

The grass from 398 acres of land in Clinton, Sterling, Boylston, West Boylston and Holden has been sold at auction for \$2,442.75.

It has been the custom each year to mow the weeds and brush on the 50-foot margin along the shore of the reservoir and on the 40-foot marginal fire guard, but, owing to the fact that the growth has become very light, it was decided to alternate between the reservoir margin and the fire guard, and during the past season the reservoir margin has not been cut.

Fences, aggregating 3,910 feet in length, have been built between property of the Commonwealth and land of Felix Nugent in Clinton and of H. F. Newton in Sterling and West Boylston, the adjoining owners in each case building one-half of the fence.

At the Wachusett Dam the maintenance work, consisting of the operation of the valves controlling the flow of water, cleaning the screens, taking care of the gate-chambers and of the grounds about the dam, has been in charge of one keeper, assisted regularly by two gate-keepers and one night watchman, and, when necessary, by one or two additional laborers.

The hydraulic gates in the lower gate-chamber, heretofore operated by water from the town of Clinton, have been connected so as to be operated by the supply from the reservoir.

The standards placed on the waste-weir in 1905 to support the stop-planks and the foot bridge were made of cast iron, the upstream portions of the standards being hollow and filled with Portland cement grout. During the first winter after they were set nearly all of the standards on the low-level portion of the waste-weir and a few of the smaller ones on the higher level became broken or cracked, due either to shrinkage strains in the metal or to the freezing of water in the hollow part of the castings. All of the standards on the low-level portion, nine in number, have been replaced with new standards made of 1-inch mild steel plate reinforced by 4-inch \times 4-inch \times $\frac{1}{2}$ -inch and 4-inch \times 3-inch \times $\frac{1}{2}$ -inch angle irons forming grooves for the stop-planks, together with other stiffening plates and connecting angles. The new standards were made by the New England Structural Company of Boston, at a cost of \$893.53, while the cost of dismantling a section of the waste-weir bridge, demolishing the old and setting the new standards, less the amount received for the material in the old standards, was \$289.97, making the total cost of repairs \$1,183.50.

The water which flowed over the waste-weir and down the waste-channel in the spring loosened from the bottom of the channel and carried down into the Lancaster Mills Pond about 680 cubic yards of stone, which had been shattered by blasting and the action of the frost. The stone accumulated in the pond thus far does no injury, but if the action continues in the future, as seems probable, it may be necessary to remove some of the stone from the pond.

The heavy wave action upon the paving on the reservoir side of the waste-weir and at the southerly end of the dam removed the small stones which had been placed in the joints of the paving. The joints on an area of about 263 square yards have been treated by filling the joints to within about 3 inches of the top of the paving with fine gravel and sand packed hard, and covering this to the face of the paving with Portland cement mortar into which were driven small granite spalls.

About 1,500 mountain laurel plants have been transplanted from the woods near the Lamson place to the grounds below the dam.

A boat landing 51 feet long by 3 feet wide has been built on a ledge outcrop near the westerly end of the waste-weir.

The fourteen dwelling houses and other connected structures at the reservoir and at the Clinton filter-beds have received necessary

repairs, including painting the exterior of the Lamson house and barn and the Cutting house, painting, papering and whitewashing the south tenement of the Lamson house, shingling the roofs of the Lamson, Sonia, Fuller and Moisen houses, and building a cesspool at the A. McLean house.

Wachusett Watershed. — In addition to the work described under the head of "Construction," in connection with the improvement of the Wachusett watershed, all apple trees on the land of the Commonwealth along the Quinepoxet and Stillwater rivers have been cut down and worked into shuttle and cord wood. There were secured 11,500 feet, B.M., of shuttle wood, which was sold for \$550.52.

Sudbury Reservoir. — At the beginning of the year the water in this reservoir was at elevation 259.65, or 0.65 of a foot above the stone crest of the overflow. From the middle of January to the middle of February water was kept from 1 to 1½ feet below the crest in order to provide storage in case of large yields from the watershed, but from the middle of March to October 23 the water was permitted to flow over the stone crest into Framingham Reservoir No. 3, the amount flowing being controlled by adjustment of the flashboards on the dam and by regulation of the quantity entering the reservoir through the Wachusett Aqueduct. After October 23 the reservoir was drawn down to facilitate work on the Southborough swimming pool, until it reached 8.16 feet below the crest of the dam, on December 5, after which date the flow in the Wachusett Aqueduct was increased for the purpose of filling the reservoir, and at the end of the year the water stood 3.23 feet below the crest of the dam.

At the gate-house of the dam two steel protection plates were placed in one of the outlet pipes to take the place of plates which had been torn off by the action of the water. Three new cast-iron plates have been placed in the gate-house floor, to replace others which had been broken. Twelve new flashboards have been made to replace others destroyed by the action of the ice and waves.

The iron and wood work in the gate-chamber, with the exception of the floor plates, the iron and wood work in the meter-chamber below the dam, and the manhole covers and iron fences near the dam have been painted.

By the construction of an earth dam across an arm of the reservoir a swimming pool, 400 feet long, with a maximum width of 60

feet and from $2\frac{1}{2}$ to $6\frac{1}{2}$ feet in depth, has been constructed, for the use of the inhabitants of Southborough, on land belonging to the Commonwealth east of Maple Street, near the Framingham-Southborough Road. Water can be admitted to the pool from the reservoir and the waste water is carried by a 6-inch Akron pipe line 1,457 feet to a sand filter-bed, 50 feet by 30 feet by 3 feet deep, through which it passes before entering the brook leading to Framingham Reservoir No. 3. The town of Southborough purchased and now owns the land on which the filter-bed is located, and also paid for all pipes, cement and other materials used in building the pool and filter-bed.

The 14 acres of filter-beds which are used for filtering the water of Marlborough Brook were cleaned in June, also the reservoir in which the brook water is received before passing on to the filter-beds. A large amount of silt and mud was removed from this reservoir and used in grading a portion of the adjacent ground on the east side of the reservoir. In the fall quite a number of cracks in the concrete aprons and dams connected with the channels and filter-beds were cut out and repointed, the office and shed were painted and brush growing around the beds was cut and burned. There was no overflow from the beds into the Sudbury Reservoir during the year.

During six days in January and four days in February and March there was a small flow of diluted sewage into the filter-bed near Farm Road, which receives the overflow from the Marlborough main sewer during freshets, and there was a flow of ground water into the bed at times during the first five months of the year.

Framingham Reservoir No. 3. — The elevation of the water in this reservoir is controlled by drafts from the Sudbury Reservoir. Water was allowed to waste into Framingham Reservoir No. 1 for a portion of the time during March, April and May, and during the remainder of the year was kept on an average about 1 foot below the stone crest of the dam. Three screens, made of No. 18 copper wire with 1-inch mesh, have been made and placed in the entrance chambers of the gate-house, for the purpose of preventing the entrance of leaves and coarse floating matter. Wooden shutters have also been made, to be placed in the entrance openings from the reservoir into the gate-house, to prevent the entrance of cold air when the water in the reservoir is below the top of the openings.

Framingham Reservoir No. 2. — No water was drawn from this reservoir for use in the Metropolitan District during the year, and the reservoir was full or overflowing for the entire year. Three screens were placed in the gate-house, similar to those described in connection with Framingham Reservoir No. 3.

Framingham Reservoir No. 1. — This reservoir was substantially full throughout the year. There was a continuous waste over the stone crest of the dam from the beginning of the year to May 24, and for a large part of the time during November and December. From May 23 to June 11 the water was lowered about $2\frac{1}{2}$ feet in order to facilitate the work of the Boston & Worcester Street Railway Company in laying paving on the reservoir slope in connection with the widening of Worcester Street. In connection with this work the abutments of the bridge crossing the reservoir just below Framingham Dam No. 3 have been extended and the bridge rebuilt. The paving on the northerly side of the road has been finished, but on the southerly side considerable filling and the placing of the paving remained to be done at the close of the year. The paving of the river channel below the dam having been undermined by the current, repairs have been made by widening the channel and laying new paving, grouted with Portland cement concrete. About 780 square feet of paving were laid in doing this work.

A wooden flume, 20 feet wide and 28 feet long, in the temporary dam on the Sudbury River, below Framingham Dam No. 1, has been repaired.

Ashland Reservoir. — At the beginning of the year the surface of the water in this reservoir was 3.75 feet below the stone crest of the overflow, but on January 14 it reached the elevation of the crest of the overflow and the reservoir remained practically full throughout the year. No water was drawn from the reservoir for the supply of the Metropolitan District. The outside of the attendant's house has been painted.

Hopkinton Reservoir. — At the beginning of the year the water in this reservoir was at elevation 300.66, or 3.34 feet below the stone crest, but on January 13 it had risen to the elevation of the crest of the overflow, and the reservoir remained full throughout the year. No water was drawn from the reservoir for the supply of the Metropolitan District. The joints under the coping stones of the waste-way were repointed for a distance of 178 feet, nearly

all of which was on the west side of the channel. The filter-beds below the dam were cleaned once during the year.

Whitehall Reservoir. — On January 1 the surface of the water in this reservoir was only 0.28 of a foot below high-water mark, and water was allowed to waste until April 7, when the reservoir was 2.29 feet below high water. On account of the small rainfall during the remainder of the year the reservoir did not reach high-water mark. There was no water drawn from the reservoir for the supply of the Metropolitan District.

Nine cottages were built during the year, making 36 cottages now located near the reservoir. There were in use during the season on the reservoir 13 motor boats, 3 sail boats, 55 row boats and 16 canoes, making 87 boats of different kinds.

The dam known as the middle dam, situated about 750 feet below the main dam, has been repaired by strengthening the retaining wall and by rebuilding the waste-way, 7.7 feet long and 14.1 feet wide, with chestnut lumber.

Farm Pond. — No water was drawn into this pond from the reservoirs on the Sudbury River, and no water was drawn from the pond for the use of the District. The town of Framingham has drawn a portion of its supply from the filter gallery alongside the pond, and during each month of the year, with the exception of the months of May and June, has drawn some water directly from the Sudbury Aqueduct.

Lake Cochituate. — The water in the lake at the beginning of the year was only 0.09 of a foot below high water, and the lake remained full until the middle of June. A draft for the supply of the District from the middle of June until the latter part of July lowered the lake about 2 feet, where it remained until November 14, when it was again drawn upon, lowering its surface about 1 foot. At the end of the year the water stood at elevation 141.78, or 2.58 feet below high water. Four new screens have been placed in the effluent gate-house for use in screening the water entering the aqueduct.

The exterior of the house occupied by the foreman has been painted.

Six hundred feet of trussed wire and 1,010 feet of galvanized ribbon wire fence have been built along Lake Avenue, and 2,500

feet of 4-strand, galvanized, duplex twisted wire fence have been built on the line between land of the Commonwealth and Edward Hammond on the east side of the lake.

The work of replacing small land bounds and setting bounds in places where none existed, to define the property of the Commonwealth around the lake, which was begun in 1907, has been completed by the setting of 274 bounds.

The work of registering boats and patrolling the lake to see that the rules of the Board were obeyed has been continued. One hundred and fifty-two boats were registered, and the registrations of 4 boats were revoked for disobedience of the rules. Eight new cottages were built, 1 burned and 2 joined together, and the number located around the lake at the end of the year was 65.

No water was drawn from Dudley Pond during the year. The elevation of the pond has ranged between 1.14 and 3.77 feet below high water. One new cottage was built during the year, making 19 now located on the shore of the pond.

The surface of Dug Pond has ranged between 0.92 of a foot above and 3.43 feet below the invert of the 18-inch overflow pipe. Water was wasted through the overflow pipe into the lake at times during each of the first six months of the year.

Water was pumped upon the Pegan filter-beds on 179 days during the year. The total quantity pumped was 265,725,000 gallons, equivalent to a daily average of 726,000 gallons. Of the total, 173,446,000 gallons were from Pegan Brook and 92,279,000 gallons from the intercepting ditch which collects water from the brooks formerly draining into Pegan Brook Meadow. The total quantity of coal consumed was 160,412 pounds, so that 1,657 gallons of water were pumped per pound of coal. The cost of operating the pumping station, cleaning the filter-beds and caring for the grounds was \$2,740.08, making the cost per million gallons treated \$10.31. The channel in the bottom of the Pegan Brook receiving reservoir was lowered and paved near the entrance of the pipes leading to the suction wells. The filter-beds were cleaned several times, and the ditches in the upper part of the Pegan Brook receiving reservoir were cleaned once during the year. Both the exterior and interior of the pumping station have been painted.

Iron stop-plank grooves have been placed at the upper side of

the culvert under Kansas Street, in which stop-planks can be placed to hold back, in time of freshets, a considerable quantity of water which now flows directly into the intercepting ditch, at times in larger quantities than can be cared for by the pumps.

SOURCES FROM WHICH WATER HAS BEEN TAKEN.

An average of 107,502,000 gallons per day was drawn from the Wachusett Reservoir through the Wachusett Aqueduct into the Sudbury Reservoir. An average of 29,965,000 gallons per day was drawn from the Sudbury Reservoir through the Weston Aqueduct into the distribution system of the Metropolitan District. From Framingham Reservoir No. 3 an average of 94,256,000 gallons per day was drawn through the Sudbury Aqueduct, and from Lake Cochituate an average of 4,027,000 gallons per day was drawn through the Cochituate Aqueduct to Chestnut Hill Reservoir. The Spot Pond drainage area furnished 82,570 gallons per day. No water was drawn from the Ashland, Hopkinton and Whitehall reservoirs nor from Framingham Reservoir No. 2 during the year, except a small quantity used in cleaning the Sudbury Aqueduct.

AQUEDUCTS.

The *Wachusett Aqueduct* has been in use on the whole or a portion of 310 days during the year. It was cleaned between November 20 and 25. The usual work of cutting brush and weeds, cleaning out culverts and farm ditches and general repairs along the aqueduct and open channel has been done.

The *Sudbury Aqueduct* was in use on 360 days of the year for conveying water from Framingham Reservoir No. 3 to Chestnut Hill Reservoir, the only interruptions to the flow having been from 11 P.M. on November 16 to 4.30 P.M. on November 20, and from 9 P.M. on November 30 to 3 P.M. on December 4, while the aqueduct was being cleaned.

Extensive repairs have been made to the brick masonry walls of the Waban Bridge, which had become disintegrated by the action of frost and from other causes during the thirty years since the bridge was constructed. In doing this work it was found necessary not only to repoint the joints but in some cases to rebuild the masonry. Work was commenced on July 30 and finished on November 25, at a cost of \$2,940. The aqueduct embankment between

the Waban Bridge and Dover Street, for a distance of 1,300 feet, has been covered with loam to a depth of from 1 to 3 inches, and fertilized and reseeded.

The aqueduct land, for a distance of 460 feet westerly from Walnut Street in Newton, which has been used in past years as a dump for débris of various kinds, has been graded so as to present a neat appearance, and fences have been built on the property lines for a length of 1,176 feet. A 4-strand ribbon wire fence was built on the property lines on both sides of the aqueduct for a distance of 524 feet west and 783 feet east of Speen Street, making, including cross fences and passageways for cattle, a total length of 3,000 feet. Manhole covers along the line and the iron floor in the east siphon chamber were painted, also the exterior trimmings of the store-house at South Framingham and the interior finish and walls of the office of the sanitary inspectors. Considerable work has been done in removing brush and small trees for the entire length of the aqueduct.

The *Cochituate Aqueduct* was in use 108 days. It was cleaned from Lake Cochituate to the Chestnut Hill pumping station between December 10 and 26. Considerable fresh-water sponge was found at various points, especially along the bottom of the aqueduct. New tongued and grooved kyanized spruce stop-planks have been put in position on the overflows from the aqueduct at three waste-weirs, to take the place of others which were decayed. Manhole covers along the line, the ironwork in the three waste-weirs, in the ventilator and in the roof of Dedman's waste-weir were painted.

A 4-strand, duplex twisted wire fence, 625 feet long, was built on the property line north of the aqueduct and easterly of Snake Brook channel, to take the place of the stone wall which was used for paving a drainage ditch; and a fence 314 feet long was built on the property line at the foot of the south slope of the high embankment at Cedar Street, Wellesley. The bottom of the south slope of the aqueduct at Morse's Pond was roughly paved for a width of 9 feet and for a distance of 210 feet for the purpose of protecting the embankment, which in places was being undermined by the waves when the pond was high in the spring. Forty land bounds have been placed along Morse's Pond and 4 near the Charles River, at points where the ground was covered with water when the bounds were being set during the previous year. Land bounds

are now in position at every angle point along the Cochituate Aqueduct.

The *Weston Aqueduct* was in service 366 days and was not cleaned during the year. The slopes of the embankment over the siphon pipes at Happy Hollow, between the road to Wayland and siphon chamber No. 4, have been repaired by the application of 136 double-team loads of loam and 1 ton of fertilizer, and have been reseeded. Some of the joints in the masonry of gaging chamber No. 1 and in 5 of the culverts between Millwood Street and Nobscot have been repointed.

PUMPING STATIONS.

Seventy-six per cent. of the water supplied to the Metropolitan District has been pumped at the two stations at Chestnut Hill Reservoir; the remainder was delivered by gravity. The total quantity pumped at all of the stations during the year was 39,156,620,000 gallons, which was 2.5 per cent. more than during the preceding year. The cost of operating the stations was \$119,201.12, equivalent to \$3.044 per million gallons pumped, or \$0.107 more than the corresponding cost during the year 1907. There was an increase in the cost of labor amounting to \$4,144.88, due to the effect of a general increase of salaries in 1907, which affected but nine months of that year, and to the employment of additional help at the Chestnut Hill high-service and Arlington stations.

The cost per gross ton of fuel used at the Chestnut Hill high-service station was \$0.135 more, and at the Chestnut Hill low-service station \$0.01 more, while at the Spot Pond station it was \$0.07 less than during the preceding year. The average cost at all the stations of raising 1,000,000 gallons of water 1 foot high was \$0.0351, — an increase of nearly 7 per cent. as compared with the previous year.

The coal purchased for use at the several pumping stations has been tested to determine the number of British thermal units and the percentage of volatile matter and ash which it contained, and the cylinder and engine oils have been tested to determine their viscosity, specific gravity and burning point. One hundred and thirty-four samples of coal and 32 samples of oil were tested.

Coal for use at the several stations has been purchased as follows: —

	GROSS TONS.					Price per Gross Ton, in Bins. ¹
	Chestnut Hill High- service Station.	Chestnut Hill Low- service Station.	Spot Pond Station.	West Roxbury Station.	Arling- ton Station.	
Spring Coal Company, bituminous, .	-	1,054.82	-	-	-	\$4 34
Spring Coal Company, bituminous, .	1,911.60	-	-	-	-	4 18
E. B. Townsend, bituminous, . . .	2,734.54	-	-	-	-	4 10
E. B. Townsend, bituminous, . . .	-	1,325.63	-	-	-	4 03
Anderson Coal Mining Company, bitu- minous.	43.62	-	-	-	-	3 97
New River Coal Company, bituminous, .	109.11	-	-	-	-	3 93
E. B. Townsend, buckwheat anthracite,	23.10	-	-	-	-	2 90
C. W. Claflin & Co., buckwheat anthra- cite.	1,818.75	-	-	-	-	2 80
C. W. Claflin & Co., buckwheat anthra- cite.	-	1,117.35	-	-	-	2 70
Locke Coal Company, bituminous, . .	-	-	306.23	-	-	5 00
Davis Coal and Coke Company, bitumi- nous.	-	-	699.03	-	-	4 14
Locke Coal Company, screenings, . .	-	-	602.93	-	-	2 24
D. J. Cutter & Co., egg,	-	-	-	139.44	-	7 28
J. A. Whittemore's Sons, egg, . . .	-	-	-	243.55	-	6 83
Wm. A. Jepson, bituminous,	-	-	-	-	141.83	4 41
Davis Coal and Coke Company, bitumi- nous.	-	-	-	-	210.24	4 05
C. W. Claflin & Co., buckwheat anthra- cite.	-	-	-	-	29.75	3 01
Philadelphia and Reading Coal and Iron Company, screenings.	-	-	-	-	163.50	2 67
Total gross tons, bituminous, . . .	4,798.87	2,380.45	1,005.26	-	352.07	-
Total gross tons, anthracite, . . .	1,841.85 ²	1,117.35 ²	-	382.99	29.75 ²	-
Total gross tons, anthracite screen- ings.	-	-	602.93	-	163.50	-
Average price per gross ton, bituminous,	\$4 130	\$4 17	\$4 40	-	\$4 19	-
Average price per gross ton, anthracite,	2 805 ²	2 70 ²	-	\$7 00	3 01 ²	-
Average price per gross ton, anthracite screenings.	-	-	2 24	-	2 67	-

¹ Includes cost of unloading coal from cars and all expenses incidental to storage of the coal.

² Buckwheat.

The contracts under which bituminous coal has been purchased during the past year have specified that the coal furnished should contain approximately 14,200 British thermal units, 18 to 20 per cent. volatile matter, 8 per cent. ash and 1 per cent. sulphur. Coal which when dry contains more than 14 per cent. ash, 23 per cent. volatile matter or 1.75 per cent. sulphur is subject to rejection.

Payments for the coal have been made on the basis of a price bid, corrected for variation in the heating value and percentage of ash as determined by samples of the coal delivered, an addition be-

ing made in cases when the number of British thermal units exceeds 14,200 and a deduction when the number falls below 14,000, or the amount of the ash exceeds 9 per cent. The average results of the tests of bituminous coals are given in the following table, including coal purchased for both the Water and Sewerage Works:—

KIND OF COAL.	Number of Samples tested.	British Thermal Units.	Percentage of Volatile Matter.	Percentage of Ash.
Barnet,	60	13,931	15.67	9.97
Carbon,	3	14,088	17.03	8.84
Vulcan,	39	14,443	20.14	7.04
Davis,	81	14,172	21.43	7.94
Georges Creek,	5	14,039	18.67	8.64

Chestnut Hill High-service Station.

At this station water is pumped for use in the high-service district of Boston, the city of Quincy and the towns of Watertown, Belmont and Milton.

The following are the statistics relating to operations at this station:—

	Engines Nos. 1 and 2.	Engine No. 3.	Engine No. 4.	Totals for Station.
Total quantity pumped (million gallons), . . .	2,814.61	381.93	10,560.93	13,757.47
Daily average quantity pumped (gallons), . . .	7,690,000	1,044,000	28,855,000	37,589,000
Total coal used (pounds),	4,935,229	409,193	8,895,838	14,240,260
Gallons pumped per pound of coal,	570.31	933.37	1,187.18	966.10
Average lift (feet),	121.62	132.94	131.09	129.20
Cost of pumping:—				
Labor,	\$7,581 65	\$478 12	\$14,707 95	\$22,767 72
Fuel,	8,592 28	718 16	15,388 20	24,698 64
Repairs,	2,217 46	58 34	2,193 50	4,469 30
Oil, waste and packing,	324 12	20 44	628 78	973 34
Small supplies,	182 73	11 52	354 49	548 74
Totals,	\$18,898 24	\$1,286 58	\$33,272 92	\$53,457 74
Cost per million gallons pumped,	\$6.714	\$3.369	\$3.151	\$3.886
Cost per million gallons raised 1 foot high, . . .	.055	.025	.024	.030

The daily average quantity pumped was 1,155,000 gallons in excess of the corresponding amount for the previous year.

The fuel economizer at this station has been thoroughly cleaned and repaired, the pump valves of the No. 4 engine overhauled and refaced, 6 new tubes placed in the feed-water heater, the smoke flue leading from the economizer to the chimney rebuilt, and No. 12 boiler repaired by replacing rings around the fire doors. The chimney at this station has been repointed and the lightning rods repaired.

Chestnut Hill Low-service Pumping Station.

The quantity of water pumped at this station was 3.1 per cent. more than during the preceding year.

The following are the statistics relating to operations at this station:—

	Engines Nos. 5, 6 and 7.
Total quantity pumped (million gallons),	21,844.65
Daily average quantity pumped (gallons),	59,685,000
Total coal used (pounds),	8,507,925
Gallons pumped per pound of coal,	2,567.56
Average lift (feet),	50.83
Cost of pumping:—	
Labor,	\$19,125 34
Fuel,	14,279 34
Repairs,	1,123 23
Oil, waste and packing,	583 44
Small supplies,	499 09
<hr/>	
Total for station,	\$35,610 44
Cost per million gallons pumped,	\$1.630
Cost per million gallons raised 1 foot high, . . . . .	.032

The cost per million gallons pumped to the reservoir was \$0.039 less than for the year 1907. The machinery in this station is now in good condition.

Spot Pond Pumping Station.

As in previous years, the greater part of the work done at this station was performed by the 20,000,000-gallon Holly engine, but the smaller Leavitt engine was used during the greater part of the month of December, while repairs were being made to the Holly engine.

The following are the statistics relating to operations at this station:—

Total quantity pumped (million gallons),	3,040.51
Daily average quantity pumped (gallons),	8,307,000
Total coal used (pounds),	2,706,751
Gallons pumped per pound of coal,	1,123.31
Average lift (feet),	129.91
Engine No. 8 operated (hours),	301
Engine No. 9 operated (hours),	3,628
Quantity pumped by Engine No. 8 (million gallons),	131.08
Quantity pumped by Engine No. 9 (million gallons),	2,909.43

Cost of pumping:—

Labor,	\$8,568 97
Fuel,	4,774 85
Repairs,	516 02
Oil, waste and packing,	267 36
Small supplies,	289 55
<hr/>	
Total for station,	\$14,416 75

Cost per million gallons pumped,	\$4.742
Cost per million gallons raised one foot high, . . . . .	.036

The daily average quantity pumped was 646,000 gallons less than during the previous year,—a reduction of 7.2 per cent. This was due to reduced consumption of water in Melrose, and in the high-service districts of Somerville, Medford, Chelsea, Malden and Everett. The cost per million gallons pumped to the reservoir was \$0.382 more than for the previous year. There was an increase of \$0.127 in the cost of repairs, and of \$0.196 in the cost of labor, the latter due to a reduction in the quantity pumped without a corresponding reduction in the cost of labor, which was almost exactly the same during the two years.

Three new valve stems have been made for the 10,000,000-gallon Leavitt engine. On the 20,000,000-gallon Holly engine a new joint was made between the bottom of the high-pressure cylinder and the cylinder head, four low-pressure valve operating levers refaced, and the boiler feed-pump plunger repaired and at the same time enlarged from $1\frac{3}{4}$ inches to $1\frac{7}{8}$ inches in diameter.

Arlington Pumping Station.

At this station was pumped all the water supplied to the town of Lexington and to the high-service district of the town of Arlington.

The following are the statistics relating to operations at this station: —

Total quantity pumped (million gallons),	279.89
Daily average quantity pumped (gallons),	765,000
Total coal used (pounds),	1,162,513
Gallons pumped per pound of coal,	240.76
Average lift (feet),	286
Engine No. 10 operated (hours),	6,145
Engine No. 11 operated (hours),	1,397
Quantity pumped by Engine No. 10 (million gallons),	237.86
Quantity pumped by Engine No. 11 (million gallons),	42.03

Cost of pumping: —

Labor,	\$5,728 53
Fuel,	1,971 15
Repairs,	776 74
Oil, waste and packing,	175 62
Small supplies,	493 47

Total for station,	\$9,145 51
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Cost per million gallons pumped,	\$32.675
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Cost per million gallons raised 1 foot high,114
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At the close of the year 1907 the new Allis-Chalmers engine was being operated in the new pumping station building, but the new Blake engine had not been delivered, and fires were being maintained under the boilers at the old station so that the old pumps could be operated without delay in case of any accident to the new plant. On February 15 the new Blake pumping engine was ready for use and the work of dismantling the old station was commenced. The buildings were razed and the grounds graded and reseeded as soon as the weather was suitable.

The daily average quantity pumped during the year shows an increase of 129,000 gallons, or 20.3 per cent., as compared with the previous year. This increase was almost entirely due to increase in the quantity used in the high-service district of Arlington.

West Roxbury Pumping Station.

At this station water was pumped for supplying the higher portions of West Roxbury and Milton.

The following are the statistics relating to operations at this station: —

Pumps operated 8,170 hours; average, 22 hours per day.

Daily average quantity of water pumped (gallons),	. . .	639,600
Daily average quantity of coal consumed (pounds),	. . .	2,304
Gallons pumped per pound of coal,	. . . . .	277.61
Average lift (feet),	. . . . .	137

Cost of pumping: —

Labor,	. . . . .	\$3,543 35
Fuel,	. . . . .	2,639 15
Repairs,	. . . . .	219 48
Oil, waste and packing,	. . . . .	31 67
Small supplies,	. . . . .	137 03

Total for station, \$6,570 68

Cost per million gallons pumped, \$28.068

Cost per million gallons raised 1 foot high,205

The quantity pumped was 45,600 gallons per day more than during the previous year.

In the report for the year 1907 it was stated that it had been necessary at times to operate both of the pumps to their full capacity, and that it would be necessary to enlarge the plant unless a considerable reduction could be made in the consumption. No reduction has been made. On the contrary, the consumption has increased, and it will be necessary to add to the pumping facilities at this station during the present year.

CONSUMPTION OF WATER.

The daily average quantity of water consumed in the 18 municipalities supplied from the Metropolitan Water Works during the year 1908, as measured by the Venturi meters, was 125,441,000 gallons, equal to 133 gallons per inhabitant in the district supplied. In addition to the above, 61,620 gallons daily were supplied to the

United States Government reservation on Peddock's Island. The daily average quantity supplied to the Metropolitan Water District, as determined by pump measurement and by the flow in the Weston Aqueduct and the estimated yield of Spot Pond, was 127,301,000 gallons, equal to 134.7 gallons per inhabitant. The excess difference of 1,860,000 gallons per day between the quantity delivered by the aqueducts and that measured by meters to the several municipalities is due to differences in methods of measurement, to leakage from the Metropolitan Water Works reservoirs and pipes, and to the use of water at the Chestnut Hill and Spot Pond pumping stations.

The daily average consumption of water in each of the cities and towns supplied from the Metropolitan Works during the years 1907 and 1908, as measured by the Venturi meters, was as follows:—

	Estimated Population 1908.	DAILY AVERAGE CONSUMPTION.					
		1907.		1908.		Increase.	Decrease.
		Gallons.	Gallons per Capita.	Gallons.	Gallons per Capita.		
Boston, . .	622,760	96,422,800	157	98,379,300	158	1,956,500	-
Somerville, . .	74,000	6,548,400	90	6,589,200	89	40,800	-
Malden, . .	40,560	1,867,600	47	1,868,600	46	1,000	-
Chelsea, . .	31,820	3,761,000	97	3,316,900	104	-	444,100
Everett, . .	32,320	2,555,000	81	2,636,300	82	81,300	-
Quincy, . .	30,430	2,996,900	102	3,003,600	99	6,700	-
Medford, . .	21,290	2,172,700	105	2,069,000	97	-	103,700
Melrose, . .	15,110	1,748,000	118	1,351,900	89	-	396,100
Revere, . .	14,580 ¹	1,240,700	88	1,293,100	89	52,400	-
Watertown, . .	12,270	796,800	67	732,000	60	-	64,800
Arlington, . .	10,460	939,800	92	971,200	93	31,400	-
Milton, . .	7,560	339,800	46	331,600	44	-	8,200
Winthrop, . .	7,840	883,400	117	928,700	118	45,300	-
Stoneham, . .	6,630	606,900	93	626,000	94	19,100	-
Belmont, . .	4,690	331,100	73	365,400	78	34,300	-
Lexington, . .	4,630	324,000	73	328,800	71	4,800	-
Nahant, . .	1,860	135,400	73	140,100	75	4,700	-
Swampscott, . .	6,550	475,300	74	509,300	78	34,000	-
District, . .	945,360	124,145,600	133	125,441,000	133	1,295,400	-

¹ Includes 280 people in Saugus.

The consumption in the several districts was as follows:—

	Gallons per Day.	Increase (Gallons per Day).
Southern low-service district, embracing the low-service district of Boston, with the exception of Charlestown and East Boston,	51,313,600	340,500
Northern low-service district, embracing the low-service districts of Somerville, Chelsea, Malden, Medford, Everett, Arlington, Charlestown and East Boston,	28,574,700	495,000
Southern high service district, embracing the high-service districts of Boston, Quincy, Watertown, Belmont, and a portion of Milton, . . .	35,804,100	854,600
Northern high-service district, embracing Melrose, Revere, ¹ Winthrop, Swampscott, Nahant and Stoneham, and the high-service districts of Somerville, Chelsea, Malden, Medford, Everett and East Boston, . . .	8,347,400	564,500 ²
Southern extra high-service district, embracing the highest portions of West Roxbury and Milton,	639,600	44,000
Northern extra high-service district, embracing Lexington and the highest portions of Arlington,	761,600	125,800
Totals,	125,441,000	1,295,400

¹ Includes a small part of Saugus.

² Decrease.

Considering the District as a whole, the consumption of water increased in the same proportion as the population, and the per capita consumption remained the same as for the preceding year. During the first three months of the year the daily average consumption of water was 5,413,000 gallons per day less, and during the following four months 8,234,700 gallons per day greater, than during the preceding year. These differences were due in great measure to much warmer weather during the winter, with a consequent reduction in the amount of water wasted to prevent freezing of service pipes, and to the very dry and hot weather during the summer.

A comparison of the per capita consumption in the several municipalities shows very clearly that in some cities and towns there is a large waste of water, although allowance must be made for differences in conditions. In Boston the quantity used for business and manufacturing is larger than in any other municipality, and the traveling and suburban population from outside the city, which uses water but is not included in the census population, affects the per capita rate. Notwithstanding these conditions the measurement of the water used in different sections of the city of Boston shows that the quantity of water used in the residential districts is excessively large.

The following table gives the population, total daily average and per capita consumption in gallons for the year 1908, in the different divisions into which the city of Boston is divided for convenience of measurement:—

DISTRICT.	Population.	Daily Average Consumption (Gallons).	Per Capita Consumption (Gallons).
Southern low-service,	352,900	51,313,600	146
Southern high-service,	169,350	30,112,400	178
Charlestown,	39,990	7,749,100	194
East Boston,	48,250	7,278,300	151
Brighton high-service,	7,830	1,299,100	166
West Roxbury extra high-service,	4,110	599,600	146
Breeds Island,	330	27,200	82
Totals,	622,760	98,379,300	158

The southern low-service district comprises the city proper with the exception, in general, of the area enclosed by Charles, Cambridge, Court, Washington and Boylston streets; also nearly all of South Boston and the lower portions of Roxbury, Dorchester and Brighton. It includes the greater part of the business and manufacturing section of the city, the railroads entering the South Station, and many of the large electric power and lighting plants that might be expected to show a very large per capita use of water. While the average of 146 gallons in this district is large, it is exceeded by the southern high-service district with 178 gallons, Charlestown with 194 gallons, East Boston with 151 gallons and the high-service district of Brighton with 166 gallons. All of these other districts are largely residential, although the southern high-service district includes several of the largest hotels and some business and manufacturing property and considerable quantities of water are used in Charlestown and East Boston by the railroads and shipping, and for manufacturing purposes.

The reduction in the daily average use in Chelsea was due to the reduction in the number of water takers after the fire on April 12. There was a large waste of water in the burned district for a considerable time after the fire, and the per capita consumption is still very large. Both Medford and Melrose show a reduction in the

quantity used, which is, without doubt, due to the more general use of water meters. In Melrose the reduction is especially noticeable. The introduction of meters was begun in this city in the latter part of 1907, and with the beginning of the year 1908 about 30 per cent. of the takers were changed from schedule to meter rates. The setting of meters was continued throughout the year, and other takers were changed from schedule to meter rates on July 1. At the end of the year practically all of the services were metered, and during the coming year all water takers will pay in proportion to the quantity of water used. The records for the past year show a daily saving of 396,100 gallons, or 29 gallons per capita, and during the last three months the per capita consumption averaged 49.3 gallons less than during the corresponding period in 1907, — a reduction of 43 per cent. A further reduction of from 10 to 15 gallons per capita will undoubtedly be made during the coming year.

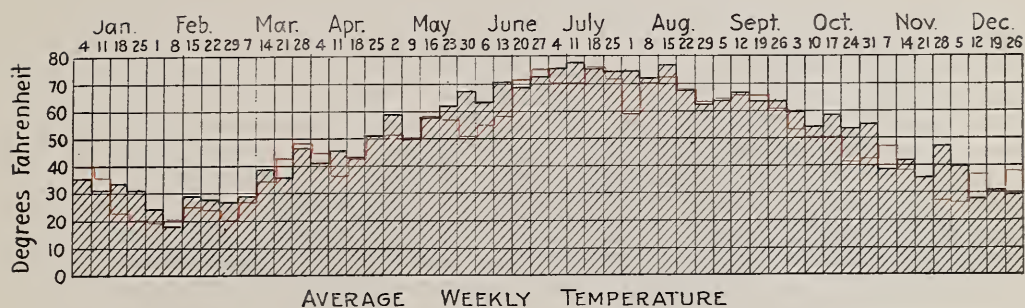
While it is generally true that 50 gallons per capita can be considered a proper allowance for residential districts, the results in Belmont, where every service pipe is metered and the per capita use was 78 gallons, is an illustration of the fact that there may be good reasons for a greater use. The large per capita consumption in this town was due to the large quantity used at the McLean Insane Asylum and by market gardeners during the long-continued dry weather.

The diagram facing this page shows graphically the average rate of consumption in the District supplied by the Metropolitan Works for each week during the years 1907 and 1908, also the rate of consumption between the hours of 1 and 4 A.M. and the average temperature of the air for the week.

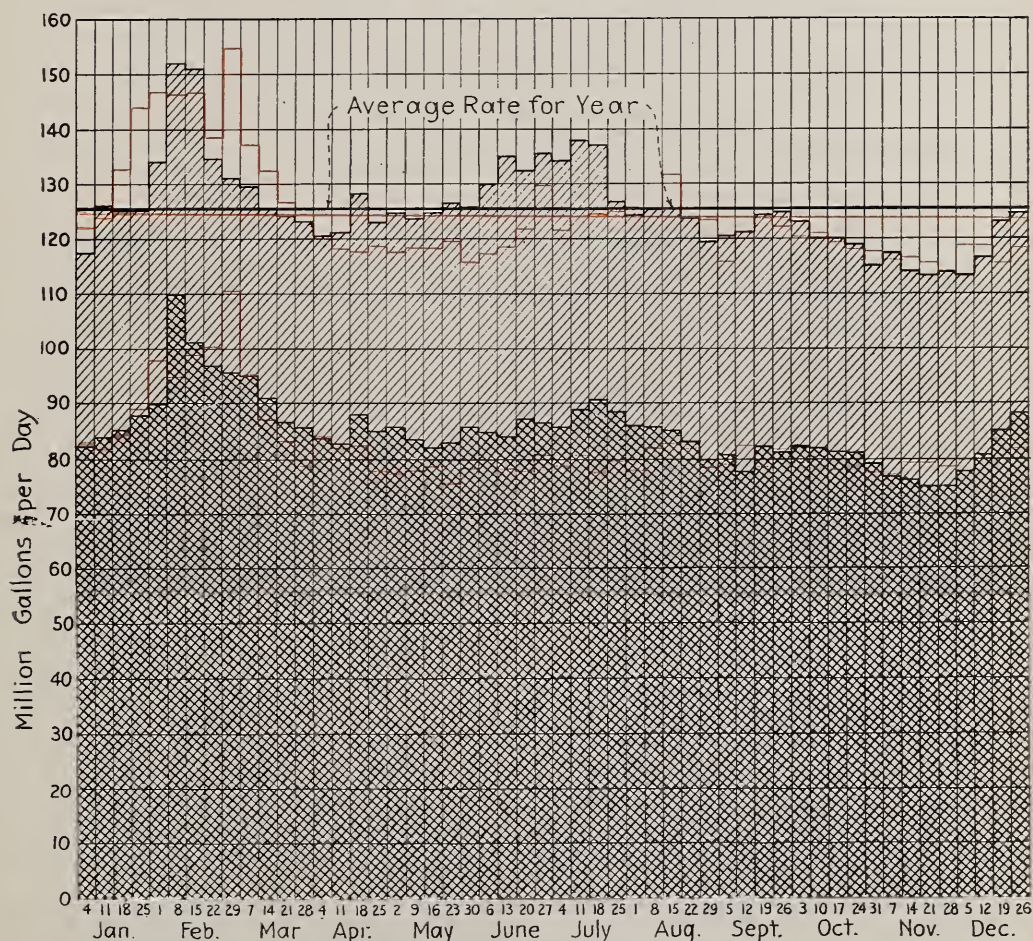
It may be noted that the weeks ending February 8 and July 11, which were respectively the weeks showing the lowest and highest average temperatures during the year, were the weeks in which the consumption of water was the greatest for each season.

Chapter 524 of the Acts of the year 1907 provides that on and after January 1, 1908, all cities and towns which derive their water from the Metropolitan Works shall equip all new service pipes with water meters, and shall also annually equip with meters 5 per cent. of the services which were unmetered on December 31, 1907. Although the city of Boston has taken no steps to comply with this

AVERAGE RATE OF CONSUMPTION
IN
METROPOLITAN WATER DISTRICT
AND
AVERAGE TEMPERATURE OF AIR AT CHESTNUT HILL RESERVOIR
FOR
EACH WEEK DURING 1908



AVERAGE WEEKLY TEMPERATURE



Average Rate of Consumption for each week, thus
 " " " " between 1 and 4 A.M. for each week, thus
 Averages in 1907 shown in red.

law, the other cities and towns have fully complied with its provisions, with the exception of Revere, where the number of meters set was about half the number required. The number of meters added during the year in the whole District was 7,084, as compared with 4,334 during the year 1907.

The following table gives the number of services in use on December 31, 1908, the number of services added and the number of meters added on both new and old services during the year 1908. In some cases the number of services installed exceeds the number of meters on new services for the reason that the laying of the service pipes precedes the setting of the meters.

CITY OR TOWN.	Number of Service Pipes laid in 1908.	Services in Use December 31, 1908.	METERS ADDED DURING 1908.			Meters in Use December 31, 1908.	Per Cent. of Services metered December 31, 1908.
			New.	Old.	Total.		
Boston, . . .	1,177	94,960	98	84	182	5,372	5.7
Somerville, . .	169	11,817	147	732	879	4,325	36.6
Malden, . . .	116	7,137	58	43	101	6,872	96.3
Chelsea, . . .	106	4,000	87	198	285	1,357	33.9
Everett, . . .	78	5,239	50	338	388	504	9.6
Quincy, . . .	312	6,403	75	358	433	1,913	29.9
Medford, . . .	132	4,510	97	856	953	1,495	33.1
Melrose, . . .	52	3,481	29	2,432	2,461	3,481	100.0
Revere, . . .	146	3,073	49	85	134	297	9.7
Watertown, . .	33	1,919	33	-	33	1,919	100.0
Arlington, . .	65	1,979	49	108	157	992	50.1
Milton, . . .	54	1,339	54	-	54	1,339	100.0
Winthrop, . .	104	2,167	104	213	317	387	17.8
Stoneham, . .	28	1,359	28	116	144	174	12.8
Belmont, . . .	57	835	57	-	57	835	100.0
Lexington, . .	39	741	36	113	149	245	33.1
Nahant, . . .	10	420	10	30	40	130	31.0
Swampscott, . .	53	1,355	53	264	317	1,209	89.2
	2,731	152,734	1,114	5,970	7,084	32,846	21.5

In the cities and towns outside of Boston 6,902 meters were added during the year, equivalent to 11.7 per cent. of the number of services in use on January 1, 1908, and at the end of the year meters had been set on 47.6 per cent. of the services.

QUALITY OF THE WATER.

The quality of the water supplied to the Metropolitan District has been exceptionally good throughout the year, due, largely, to the fact that a much larger proportion of the supply than ever before was drawn from the Wachusett Reservoir. About 83 per cent. of the water used was supplied from this reservoir, 14 per cent. from the Sudbury Reservoir and Framingham Reservoir No. 3, and 3 per cent. from Lake Cochituate. In almost every respect the results of the examinations show that the water supplied has been better than for many years. The number of organisms increased somewhat, but they were not of an objectionable character.

Samples of the water have been collected monthly from 24 points and semimonthly from 5 points on the works, and sent to the State Board of Health for chemical analysis. Samples of water have also been collected weekly at 35 points and biweekly at 8 points, and examined microscopically and for color, odor, taste and turbidity in the biological laboratory of the Metropolitan Water and Sewerage Board.

The following table gives a comparison of the average results of the examinations of water from a tap in Boston for the years 1901 to 1908, inclusive:—

	1901.	1902.	1903.	1904.	1905.	1906.	1907.	1908.
<i>State Board of Health Examinations.</i>								
Color (Nessler standard), . . .	0.24	0.26	0.25	0.23 ¹	0.24 ¹	0.24 ¹	0.22 ¹	0.19 ¹
Total residue,	4.43	3.93	3.98	3.93	3.86	3.86	3.83	3.50
Loss on ignition,	1.64	1.56	1.50	1.59	1.59	1.39	1.40	1.35
Free ammonia,	0.0013	0.0016	0.0013	0.0023	0.0020	0.0018	0.0013	0.0011
Albuminoid am- { total,	0.0158	0.0139	0.0125	0.0139	0.0145	0.0159	0.0129	0.0115
monia, { dissolved,	0.0143	0.0119	0.0110	0.0121	0.0124	0.0134	0.0109	0.0092
{ suspended,	0.0015	0.0020	0.0015	0.0018	0.0021	0.0025	0.0020	0.0024
Chlorine,	0.30	0.29	0.30	0.34	0.35	0.34	0.33	0.33
Nitrogen as nitrates,	0.0173	0.0092	0.0142	0.0110	0.0083	0.0054	0.0068	0.0092
Nitrogen as nitrites,	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001
Oxygen consumed,	0.42	0.40	0.39	0.37	0.35	0.36	0.32	0.26
Hardness,	1.7	1.3	1.5	1.5	1.4	1.3	1.3	1.2
<i>Metropolitan Water and Sewerage Board Examinations.</i>								
Color (platinum standard), . . .	34	33	35	32	28	25	27	22
Turbidity,	2.0	2.3	2.2	2.4	1.9	2.2	2.2	2.4
Total organisms,	243	367	286	303	528	550	427	695
Amorphous matter,	38	34	36	36	37	42	47	64
Bacteria,	162	164	126	176	231	154	176	148

NOTE.—Chemical analyses are in parts per 100,000, organisms and amorphous matter in standard units per cubic centimeter, and bacteria in number per cubic centimeter. The standard unit has an area of 400 square microns, and by its use the number of diatomaceæ are decreased, and the number of chlorophyceæ and cyanophyceæ are very much increased, as compared with the number of organisms.

1 Platinum standard.

In the biological laboratory there have been made 2,459 microscopical and 1,215 bacterial examinations of water collected at various points upon the works. Of the microscopical examinations 1,926 were of the regular weekly and biweekly samples and 533 were special examinations.

The bacteriological work consisted of routine weekly examinations, monthly examinations of the main feeders of the Sudbury Reservoir, of Framingham Reservoir No. 3 and of Lake Cochituate, and monthly tests of the efficiency of the Pegan Brook, Marlborough Brook and Sterling filter-beds.

The water of the Wachusett Reservoir has been free from objectionable organisms, and the water at the bottom of the reservoir showed no indications of stagnation. The water in the Sudbury Reservoir and in Framingham Reservoir No. 3 was largely supplied from the Wachusett Reservoir, and has been of good quality. The number of organisms in the water has been larger than usual, but they were principally diatoms, and not of a character to cause disagreeable tastes and odors. A small growth of *Uroglena* was present in the Sudbury Reservoir in January, but it did not cause a noticeable taste in the water supplied to the District. The quality of the water was somewhat improved by aeration while passing over the overflow of the Sudbury Dam.

In Lake Cochituate there was a large growth of microscopic organisms, largely diatoms, and during the greater portion of the year there was a sufficient number of either *Chlamydomonas*, *Aphanizomenon*, *Anabæna* or *Synura* to give the water an objectionable taste and odor.

The water in Framingham Reservoir No. 2 and in the Ashland, Hopkinton and Whitehall reservoirs always has a much higher color than the water from the Wachusett and Sudbury reservoirs or Lake Cochituate, and for that reason no water was drawn from these reservoirs during the year for supplying the District. There was a large growth of *Clathrocystis* in Framingham Reservoir No. 2 and in the Ashland Reservoir during August and September. A growth of *Synura* appeared in Whitehall Reservoir early in October, lasting until the end of the year, and giving the water a very objectionable oily odor.

The water in the distributing reservoirs has been generally free from objectionable organisms. There was a growth of *Uroglena*

in the Waban Hill Reservoir in the latter part of January, and a growth of *Synura* in the Weston Reservoir for a week early in July. At Spot Pond *Uroglena* appeared in February and again in June, and there was a small growth of *Dinobryon* in September, but the water acquired but little taste or odor and the growths continued for but a short time.

SANITARY INSPECTION.

The sanitary inspection of the watersheds has been continued under the immediate supervision of William W. Locke, Sanitary Inspector. A force varying from 3 to 12 men has also been employed to patrol the several reservoirs for the purpose of detecting any violations of the regulations of the Board relative to boating, fishing, hunting, polluting the water or injuring the property of the Commonwealth.

On the Wachusett watershed 4 cases of typhoid fever were reported in Holden, 1 in West Boylston and 1 in Boylston, as compared with 5 cases of typhoid fever and 1 of dysentery during the previous year.

On the Sudbury and Cochituate watersheds 5 cases of typhoid fever were reported in Marlborough, 5 in South Framingham, 9 in Natick, 3 in Southborough and 2 in Westborough, a total of 24, as compared with 30 during the year 1907. In 14 of these cases the patients resided in houses connected with the public sewers which discharge outside the watershed. In all cases precautions were taken to protect the water supply from danger of pollution.

There was an epidemic of dysentery in Natick during July, August and September, with 118 cases and 20 deaths. There were also 3 cases reported in South Framingham.

The sanitary conditions on the Wachusett watershed have been improved by the removal of 17 buildings, 10 of which were on property belonging to the Board, and by the construction of 7 cesspools.

On account of the business depression very little work has been done at the mills on the Quinepoxet River in Holden, and as a result there has been a noticeable reduction in the population of the town.

On the Sudbury watershed 51 old and 9 new premises were connected with the public sewers which convey the drainage outside

the watershed. Fourteen of these premises are in Marlborough, 34 in Westborough and 12 in Framingham. On the Cochituate watershed 71 old and 11 new premises were connected with the public sewers. Twenty-six of these are in Framingham and 56 in Natick.

In the four places above mentioned which have systems of sewerage which convey the drainage outside the watersheds, there were, on December 31, 1908, 3,882 premises connected with the sewers and 286 premises not yet connected on streets where there are existing sewers, as follows:—

	Premises connected with Sewers.	Premises not connected with Sewers.
Marlborough,	1,502	90
Westborough,	479	51
Framingham,	1,029	25
Natick,	872	120
Totals,	3,882	286

During the year a number of persons were apprehended in violations of the regulations of the Board. Seven persons were summoned into court for violations of the fishing regulations at the Sudbury Reservoir, and 4 of them were fined. Eleven persons were discovered bathing in the Sudbury Reservoir. Several of these could not afterward be found, having given incorrect names or addresses, but 8 were summoned into court and 6 were fined sums ranging from \$2 to \$5. Two persons were discovered bathing in Whitehall Reservoir and fined \$2 each. A number of boys, generally young, were discovered bathing in Dug Pond. Seven of these were summoned into court where, on account of their youth, their cases were placed on file, with an admonition from the judge that a second offence would be followed by fine. At Dudley Pond several men were discovered bathing, but as they were visitors at summer cottages and gave false names and addresses they could not afterward be found. Under authority given by chapter 539 of the Acts of 1908 a number of the employés of the Board have been authorized to arrest without a warrant persons discovered

bathing in any of the reservoirs or streams used for public water supply, so that in the future discovery will be more likely to be followed by appearance in court. One man was apprehended hunting on land of the Commonwealth at the Sudbury Reservoir, and was fined \$20 by the judge of the Westborough court.

The cutting of ice at Framingham Reservoirs Nos. 2 and 3, the Sudbury and Whitehall reservoirs, and Dudley and Waushacum ponds, has been inspected to see that the work was done in such a way as to prevent pollution of the water supply.

A summary of the work of sanitary inspection for the year 1908 is given in the following four tables. The first table shows for the Wachusett watershed the number of premises inspected, the classification of cases inspected, and the condition of the premises at the end of the year; the second table gives the corresponding information for the Sudbury and Cochituate watersheds; the third table shows the improvements effected on the Wachusett watershed; and the fourth table the improvements effected on the Sudbury and Cochituate watersheds.

The headings of these tables are easily understood, except in a few instances: under the heading "Premises Vacant" are included all cases which at present furnish no objectionable drainage, but which might furnish such drainage if the premises were occupied; under the heading "Unsatisfactory" are included all cases where there may be, under the most unfavorable conditions, wash from privies or direct sink drainage, all suspected cases, and all cases of manufacturing wastes entering feeders, even though there may be some attempt at previous purification.

In the third and fourth tables no cases are entered as remedied unless complete sewer connections have been made, or all probability of future contamination has been removed; and no cases are entered as partly remedied except where positive improvement in the sanitary condition has been effected.

Summary of Sanitary Inspections on the Wachusett Watershed in 1908.

DISTRICT.	Number of Premises inspected. ¹	CLASSIFICATION OF CASES INSPECTED.									CONDITION AT END OF YEAR.	
		Cesspools dug before 1908.	Cesspools dug in 1908.	Direct Privy Drainage.	Indirect Privy Drainage.	Direct Sink Drainage.	Indirect Sink Drainage.	Manure Piles.	Manufacturing Wastes.	Premises Vacant.	Satisfactory.	Unsatisfactory.
French Brook,	60	30	-	-	-	-	4	33	-	5	58	2
Muddy Brook,	32	10	1	-	-	-	6	24	-	-	32	-
Gates Brook,	139	95	3	-	-	-	4	58	-	5	138	1
Malden Brook,	17	9	-	-	-	-	-	14	-	1	17	-
Chaffin Brook,	167	75	6	-	1	-	13	78	1	16	157	10
Asnebumskit Brook, . .	281	157	5	1	8	20	25	97	1	17	248	33
Muschopauge,	95	26	2	-	2	5	6	52	1	7	85	10
South Wachusett Brook,	83	22	1	1	2	1	6	36	-	11	75	8
Trout Brook,	37	4	-	-	-	-	3	24	1	7	35	2
East Wachusett Brook, .	208	61	2	2	3	5	23	109	-	7	191	17
Stillwater River, . . .	148	47	3	-	2	1	8	85	-	6	143	5
Waushacum,	163 ²	49	1	-	2	1	6	61	-	8	156	7
French Hill,	28	17	2	-	-	-	-	15	-	3	28	-
Totals,	1,458	602	26	4	20	33	104	686	4	93	1,363	95

¹ On some premises there are 2 or more cases.² Not including 205 summer cottages located near the Waushacum Lakes.*Summary of Sanitary Inspections on the Sudbury and Cochituate Watersheds in 1908.*

DISTRICT.	Number of Premises in- spected. ¹	CLASSIFICATION OF CASES INSPECTED.									CONDITION AT END OF YEAR.	
		Cesspools dug before 1908.	Cesspools dug in 1908.	Direct Privy Drainage.	Indirect Privy Drainage.	Direct Sink Drainage.	Indirect Sink Drainage.	Manure Piles.	Manufacturing Wastes.	Premises Vacant.	Satisfactory.	Unsatisfactory.
<i>Sudbury Watershed.</i>												
Farm Pond,	249	8	1	-	-	-	-	20	-	5	248	1
Framingham Reservoir No. 3,	71	35	1	-	-	-	35	50	-	-	68	3
Stony Brook,	289	208	4	-	1	2	46	113	-	18	271	18
Angle Brook,	1,983	290	4	1	4	5	129	248	1	68	1,916	67
Framingham Reservoirs Nos. 1 and 2, and Cold Spring Brook,	270	104	3	-	2	-	102	111	-	27	261	9
Eastern Sudbury,	238	206	4	-	2	1	43	42	-	7	226	12
Indian Brook,	419	171	-	-	2	7	168	83	-	60	386	33
Western Sudbury,	184	64	-	-	3	3	77	50	1	30	157	27
Whitehall Reservoir,	111	22	-	-	1	1	74	37	-	11	100	11
Cedar Swamp,	804	180	-	-	1	6	83	128	1	50	789	15
<i>Cochituate Watershed.</i>												
Snake Brook,	319	220	2	-	-	3	94	68	-	6	294	25
Pegan Brook,	928	232	-	-	1	4	71	110	1	30	902	26
Course Brook,	88	49	-	-	-	-	29	41	-	6	86	2
Beaver Dam Brook,	1,089	179	3	-	1	2	76	180	3	16	1,042	47
Dug Pond,	500	150	-	-	3	7	34	49	-	8	478	22
Totals,	7,542	2,118	22	1	21	41	1,061	1,330	7	342	7,224	318

¹ On some premises there are 2 or more cases.

Sanitary Improvements effected on the Wachusett Watershed in 1908.

DISTRICT.	Remedied. ¹	Partly remedied.	DISTRICT.	Remedied. ¹	Partly remedied.
French Brook, . .	6	-	South Wachusett Brook,	-	-
Muddy Brook, . .	-	1	Trout Brook, . .	1	-
Gates Brook, . .	1	1	East Wachusett Brook,	2	-
Malden Brook, . .	-	-	Stillwater River, . .	2	-
Chaffin Brook, . .	1	-	Waushacum, . .	1	2
Asnebumskit Brook, .	2	-	French Hill, . . .	-	-
Muschopauge, . .	1	3	Totals, . . .	17	7

¹ Including buildings torn down or removed.

Sanitary Improvements effected on the Sudbury and Cochituate Watersheds in 1908.

DISTRICT.	Remedied by Sewer Connection.	Otherwise remedied. ¹	Partly remedied.	Cesspools abandoned on Account of Sewer Connections.
<i>Sudbury Watershed.</i>				
Farm Pond,	8	-	1	8
Framingham Reservoir No. 3, . . .	-	-	1	-
Stony Brook,	-	1	4	-
Angle Brook,	9	-	4	6
Framingham Reservoirs Nos. 1 and 2 and Cold Spring Brook.	-	1	3	-
Eastern Sudbury,	-	1	4	-
Indian Brook,	-	-	-	-
Western Sudbury,	-	-	-	-
Whitehall Reservoir,	-	-	-	-
Cedar Swamp,	34	6	-	29
<i>Cochituate Watershed.</i>				
Snake Brook,	-	1	2	-
Pegan Brook,	29	-	-	24
Course Brook,	-	-	-	-
Beaver Dam Brook,	18	-	3	15
Dug Pond,	24	-	-	22
Totals,	122	10	22	104

¹ Including buildings burned, torn down or removed.

SWAMP DITCHES AND BROOKS.

The drainage ditches in swamps on the several watersheds, aggregating 36.36 miles in length, have been cleaned, and the weeds and brush mowed and burned for a width of from 10 to 20 feet on either side of the ditches. On the Wachusett watershed about 2,150 feet of ditches in swamp No. 76 in Sterling, and 820 feet in swamp No. 2 in Boylston, were repaved where the paving had been trampled out by cattle or washed out during times of high water. A standard board bottom ditch, with paved slopes, 1,440 feet long, was constructed through and above a small shallow flowage fill on the shore of Stillwater basin, and for about 300 feet, to drain a small swamp in Boylston preparatory to planting same with pine trees. Five bridges crossing ditches in swamps Nos. 1, 2 and 5 in Boylston have been rebuilt with 2-inch chestnut plank. On the Sudbury watershed the ditch on Deerfoot Brook was repaved for a distance of about 290 feet, and for 85 feet of this distance the board bottom of the ditch was also renewed. The ditches on Mowry, Broad Meadow and Brewer brooks were repaired by ramming the paving into place and relaying the paving in Broad Meadow Brook for a distance of 300 feet. Six farm crossing bridges were rebuilt.

Observations of the color of water from swamps which have been drained have been made monthly.

The effect upon the color of water flowing from several of the larger swamps which have been drained is shown by the following tabular statement:—

SWAMP.	Area of Watershed (Acres).	Area of Swamp (Acres).	Length of Ditches (Feet).	COLORS OF WATERS (PLATINUM STANDARD).			
				BEFORE DRAINING.		AFTER DRAINING.	
				Averages for Years 1894, 1895, 1899.	Averages for Years 1900, 1901, 1902.	1907.	1908.
Crane, . . .	1,856	460	45,250	195	—	77	72
No. 54, . . .	750	72	8,980	—	90	53	41
No. 55, . . .	1,625	220	27,661	—	127	80 ¹	44
No. 76, . . .	225	26	6,173	—	44	27	24

¹ Nearly one-half of the ditches in swamp 55 were not built until 1907.

PROTECTION OF SUPPLY.

On the Wachusett watershed the underbrush and small trees have been cut from about 15 acres of land lying north of the Central Massachusetts Railroad and between the Wachusett Dam and North Dike. This was done in order to remove the shelter which the underbrush afforded to sightseers and others who were making the locality objectionable from a sanitary standpoint.

A lot of land near Beaver Dam Brook in South Framingham has been for several years used as a dump for refuse material, and constant inspection has been necessary to prevent the dumping of objectionable matter in close proximity to the brook, which is one of the principal feeders of Lake Cochituate. The land has recently been purchased by the Dennison Manufacturing Company, and this company has taken measures to prevent the dumping of any objectionable material in the immediate vicinity of the brook.

In 1907 an agreement was made with the selectmen of the town of Framingham by which the Board agreed to pay \$2,500 toward the cost of constructing a new covered channel, about 1,800 feet long, to take the place of the open ditch which was formerly used by the city of Boston in running water from Farm Pond to Beaver Dam Brook; also of cleaning out and improving the brook channel for a further distance of 2,700 feet. The work has been substantially completed during the past year, and will result in the removal of the unsightly sluggish ditch which has been a receptacle for much objectionable refuse during recent years.

FORESTRY.

On land around the Wachusett Reservoir an area of 212 acres was planted during the year, 62 acres between April 6 and 18, and 150 acres between September 18 and October 9. Of the above, 86 acres were in light grass-land, 73 acres pasture, 47 acres sprout land and 6 acres in drained swamps. In doing this work there were used 253,610 white pines from the Flagg nursery, 3,080 Norway spruces and 8,285 locusts from the Lamson nursery. The cost of removing trees from the nursery and planting them has averaged \$5.50 per thousand trees, or \$6.40 per acre. The cost was somewhat larger than in previous years, due to greater distance of the

planted areas from the nurseries and larger percentages of swamp and sprout land, in which the cost of planting is greater.

The following table gives the information regarding land belonging to the Board around the reservoir, not including outlying land and land along the Quinepoxet River above the reservoir:—

	Acres.
Area of land which was forested when acquired, not since improved, .	1,266
Area of land which was forested when acquired, and since improved, .	209
Area which has been planted with trees,	842
Area which has been planted with trees, and cleared,	488
Area to be planted with trees,	39
Area open, which will probably not be planted,	339
Area of marginal strip along shores of reservoir,	197
<hr/>	
Total area,	3,380

Necessary care has been given to the Flagg and Lamson nurseries. The Flagg nursery now contains 64,200 white pines and 28,300 arbor vitæ. In the Lamson nursery there are 154,200 arbor vitæ, 4,000 sugar maples, 2,800 ashes, 2,600 locusts, 2,170 white oaks, 1,150 walnuts and 54 catalpas. The maples, oaks and walnuts are dying in spite of considerable care, and will probably not warrant the expense of transplanting in the field.

Work has been continued on the cutting out of all trees and brush which interfere with the growth of the young pines. About 324 acres of land have been treated in this manner, at a cost of about \$5.85 per acre. Undesirable and mature trees were cut on about 10 acres preparatory to planting pine trees. The work of making an improvement thinning in the ten-year-old forest of white oaks, maples and walnuts on Nashaway Island has been completed. An area of 8 acres was thinned out, at a cost of about \$22 per acre.

About 3,770 feet of forest roads have been built to take the place of roads submerged by the filling of the reservoir. The brush and weeds on the 40-foot marginal fire guard and on all forest roads have been mowed and burned.

On land around the Sudbury Reservoir about 4,300 pine trees were planted and a few maples were set out alongside the road leading to the dam. A number of pine trees were also planted at the Weston Reservoir and at several points along the line of the Weston Aqueduct.

Very considerable work has been done in cutting out underbrush and undesirable trees, for the double purpose of affording desirable trees a better opportunity to grow and of removing hiding places for the gypsy and brown-tail moths. This work also results in a very decided improvement in the appearance of the property. Work of this character has been done by the regular force of employés as opportunity offered on lands at the Sudbury and Whitehall reservoirs, Framingham Reservoirs Nos. 2 and 3, Lake Cochituate, Sudbury and Cochituate aqueducts, Weston Reservoir and Spot Pond. The work of protecting trees on Water Works property from the ravages of the gypsy and brown-tail moths, elm-leaf beetle and pine-tree weevil has necessitated the expenditure of about \$7,550 during the year, which has been distributed as follows:—

Spot Pond and Fells Reservoir,	\$3,860
Chestnut Hill Reservoir,	780
Weston Reservoir and Aqueduct,	1,230
Mystic Lake, Pumping Station and Reservoir,	250
Sudbury and Cochituate Aqueducts,	325
Lake Cochituate,	275
Sudbury Reservoir,	270
Reservoirs in Framingham, Ashland and Hopkinton,	60
Wachusett Reservoir and Aqueduct,	500
	<hr/>
	\$7,550

This was \$3,150 less than during the previous year, due very largely to the thorough work done on the property around Spot Pond during the past few years.

The methods followed have been the same as in previous years, namely, painting egg clusters of the gypsy moths with a mixture of creosote and fuel oil, cutting off and burning the nests of the brown-tail moths, banding the trees with tanglefoot early in the spring, to prevent the caterpillars from ascending the trees, spraying with arsenate of lead all trees which were found to be infested with moths, and banding with burlap the trees in places where moths were known or suspected to be present, and destroying the full-grown caterpillars which collected under the burlap. Trees infested with elm-leaf beetles were sprayed with arsenate of lead, and the trees were scraped from the ground to a height of from eight to ten feet.

At Spot Pond the egg clusters of the gypsy moth were painted and the nests of the brown-tail moths were cut off and burned. In April 1,500 pounds of tanglefoot were used in banding trees. Later in the season the trees on eight acres were sprayed with arsenate of lead.

At Chestnut Hill Reservoir the trees and shrubbery were sprayed three times in order to protect them from the moths and elm-leaf beetles. The cost of protecting the trees, at both the Chestnut Hill and Weston reservoirs, has been much increased on account of the neglect of owners of adjoining property.

Along the line of the Cochituate, Sudbury and Weston aqueducts the gypsy moths were destroyed and the egg clusters painted in considerable numbers in Newton and Weston, and a few were found in Wellesley, Natick and Framingham.

At Lake Cochituate about 300 egg clusters of the gypsy moth were found and destroyed, generally in the vicinity of summer camps.

During the past year, for the first time the gypsy moths have been found at several points on the Water Works property west of Framingham, a few at Framingham Reservoirs Nos. 2 and 3, and considerable numbers at the Whitehall Reservoir in Hopkinton.

At the Sudbury Reservoir about 13,000 nests of the brown-tail moths were destroyed, and a considerable number of large elm trees in Southborough were scraped and sprayed to destroy the elm-leaf beetles.

No gypsy moths have been found on Water Works property on the Wachusett watershed, but large numbers of the brown-tail moths have been destroyed in the vicinity of the dam at Clinton, and a few nests have been found at the upper end of the reservoir.

The young pine trees on land around the Wachusett and Sudbury reservoirs, of which about one million have been planted during the past six years, were, in the middle of the summer, found to be infested with the pine-tree weevil, which cuts off the young shoots, generally the leader, at the top of the tree. The weevils were destroyed by cutting off and burning the affected shoots.

DISTRIBUTING RESERVOIRS.

The distributing reservoirs maintained by the Board are the Weston and Chestnut Hill reservoirs; the Waban Hill and Forbes Hill reservoirs and the Forbes Hill standpipe of the southern high-service system; Spot Pond and the Mystic Reservoir near Tufts College of the northern low-service system; the Fells and Bear Hill reservoirs of the northern high-service system, and the Arlington standpipe of the northern extra high-service system.

Weston Reservoir.

No work has been done at this reservoir other than that required to keep the grounds and buildings in good order. A large part of the work required has been in connection with the protection of the trees and shrubs from the gypsy and brown-tail moths. The reservoir, with its buildings and grounds, is in good condition.

Chestnut Hill Reservoir.

This reservoir, with its gate-houses and grounds, including the grounds around the pumping stations, has received the usual care. The high retaining wall along the driveway on the north side of the reservoir has been repointed. The work of reconstructing and resurfacing walks around the reservoir has been continued, and 300 linear feet of walk were rebuilt and 1,500 linear feet of walk were resurfaced with stone dust. The driveways between the Lawrence and Bradlee basins, and the roadway of Beacon Street in front of the pumping stations, have been sprinkled seven times with an oil emulsion for the purpose of laying the dust. The cost for the season was about 2 cents per square yard, which was less than the previous cost for sprinkling with water, and the results were much more satisfactory. The ironwork in the gate-houses has been scraped and painted. On account of the large number of people who visit the reservoir grounds during the summer it has been necessary to maintain a police force of from three to five men on duty on Sundays and evenings during the summer season. About 55 square yards of granolithic walk have been rebuilt in front of the low-service pumping station, where the walk had settled and cracked on account of the breaking of a high-service force main in 1907.

Waban Hill Reservoir.

The reservoir and grounds have received the usual care and are in good condition.

Forbes Hill Reservoir and Standpipe.

No other work than the usual care of the grounds and structures has been required at this reservoir. The standpipe has been in constant use, and the reservoir has been kept full of water but has not been drawn upon for the supply of the District.

A recording gage was connected with the standpipe in August, by means of which a constant record is now kept of the elevation of the water in the standpipe.

Spot Pond.

Early in February Spot Pond was lowered about one foot on account of the large consumption of water during the extreme cold weather, and during both November and December it was lowered for a few days about the same amount in order to furnish water to the District while the Sudbury Aqueduct was shut off for cleaning. With these exceptions the pond remained very near high-water mark throughout the year.

In addition to the routine work connected with the care of the reservoir, the cellar on the site of the Butterfield house has been filled, and the ground loamed and seeded. The foreman's house and the barns on what were formerly the Bottume and Butterfield estates have been painted.

Considerable time has been expended in endeavoring to prevent gulls and ducks from frequenting the pond, as their presence is considered to be a menace to the purity of the water. When not disturbed both gulls and ducks frequent the pond in large numbers, careful estimates making the numbers from 500 to 2,000 on different days during November and December. As a result of their presence the rocky islands, several of which rise but little above the level of the water in the pond, were covered with a deposit of excrement which is washed into the water by the rains and waves. The ledges at some points became so covered with this deposit that the black rocks were given a white appearance. From November

9 to 19 and from December 5 to 12 blank cartridges were fired by men stationed at different points around the pond, for the purpose of disturbing the birds so that they would leave. The result was not satisfactory, as the birds, particularly the gulls, continued to frequent the pond though in reduced numbers so long as the firing was continued, and returned in large numbers as soon as it ceased. It is possible that by constantly patrolling the pond with a motor boat and using blank cartridges, nearly, if not quite all of the birds may be prevented from frequenting the pond. The birds also frequent the Chestnut Hill Reservoir, but in smaller numbers.

Mystic Reservoir.

This reservoir has been in use throughout the year, and has received the usual care. The brickwork of the gate-house has been pointed, and steps on the embankment painted.

Fells and Bear Hill Reservoirs.

These reservoirs have been in constant use during the year, have required no other work than the usual care, and are both in good condition.

Arlington Standpipe.

This standpipe has required no special attention. The walks and driveways were washed by overflow from the standpipe and have been resurfaced.

Mystic Lake and Pumping Station.

The gate-house at the lake has been painted and the property is in good condition.

Extensive repairs have been made on the interior of the house occupied by the Superintendent of Pipe Lines and Reservoirs on the pumping station grounds, and this, with the stable and storage buildings, has been painted and is now in good order.

Glenwood Yard.

The fence on three sides of the yard has been painted. The buildings are in good order.

Chestnut Hill Yard.

A new maple floor has been laid in the office, and the exterior of the carpenter's shop, office building and part of the blacksmith shop have been painted.

PIPE LINES.

The length of the pipe lines owned and maintained by the Metropolitan Water and Sewerage Board on December 31, 1908, was 84.65 miles, and the length of the mains not less than 4 inches in diameter connected with the works, but owned and operated by the several cities and towns supplied with water, was 1,484.2 miles.

Twenty-two leaks have been repaired on the pipe lines maintained by the Board, at a cost of \$1,377.42. The more important of these were a break in the 36-inch high-service main supplying West Roxbury, Dorchester, Quincy and Milton, which occurred on Morton Street near Washington Street, in West Roxbury, on February 6, and a break in a 24-inch pipe on Broadway near Marshall Street, in Somerville, on June 13. In both instances the breaks occurred where the pipes lay in a trench excavated in rock, and were apparently due to the fact that the pipes had settled so as to rest on points of the ledge. In both cases large volumes of water escaped from the broken pipes, and the surface of the streets in the vicinity was washed to a considerable extent. The cost of repairing the damages caused by the leak in West Roxbury was \$632.44, and of the one in Somerville \$312.25. The remainder of the leaks were small and due to defective lead joints.

All valves on the pipe lines have been inspected, cleaned and oiled, and all air valves tested. An additional connection 16 inches in diameter has been made at the junction of Arborway and South Street in West Roxbury, between the 48-inch high-service main and the 20-inch main supplying water to West Roxbury, for the purpose of supplying that district whenever the main south of this point is shut off for repairs.

The 36-inch main crossing Washington Street at Forest Hills in West Roxbury was relocated for a distance of 165 feet, to permit of the construction of the piers supporting the Boston Elevated Railway structure. The cost of doing this work, amounting to \$2,473.51, was paid by the Railway Company.

The pipe bridges over the Pines rivers in Revere and Saugus, over the Saugus River between Saugus and Lynn, and at the Chelsea North Bridge between Chelsea and Charlestown, have been painted. The iron beams supporting the pipes over the New York, New Haven & Hartford Railroad at Milton have been recovered with sheet lead $\frac{1}{8}$ of an inch in thickness. The 36-inch steel pipe over Stony Brook in West Roxbury has been scraped and painted.

VENTURI METERS.

The number of Venturi meters connected with the pipe system on December 31, 1908, was 59, and 46 of these were in constant use throughout the year. The work of winding and caring for the operating mechanism, and taking the weekly readings to determine the consumption of water in the different municipalities, has been attended to by two assistants.

PRESSURE REGULATORS AND RECORDING GAGES.

No change in the number or location of the pressure regulators was made during the year. A new piston and lining were placed in the float operated valve at the Chelsea Reservoir in April, and a new piston and lining, with a centre guided stem were placed in the valve regulating the pressure to the town of Swampscott on August 9.

A Crown pressure recording gage was set on October 29 in the police station in Chelsea Square, to replace the one destroyed in the Water Works office during the fire of April 12. A similar gage was installed at the Forbes Hill standpipe on August 4.

The recording gage in Belmont has been transferred from the town hall to the water works shop on Waverley Street.

The average maximum and minimum elevations of the water, due to the pressure at nineteen points in different parts of the District, as recorded by the gages, are given in Appendix No. 2, Table No. 39.

ELECTROLYSIS.

The electrical pressures between the pipe lines and street railway tracks and the electric currents flowing over the water pipes were determined over the entire distribution system during June

and July. On account of the large currents measured on the low-service pipe lines in Brighton, Cambridge and Somerville in June, measurements were repeated on these lines in September. Diagrams have been plotted showing the relative potentials of the pipes and rails and the intensity of electric currents flowing on the pipe lines during the year, for comparison with the conditions in previous years.

Miscellaneous electrical measurements were made at various times during the year, in connection with the installation of new insulating joints and on account of other special conditions which occurred during the year.

Four insulating joints have been installed during the year, as follows: —

Insulating joint No. 20, located in Atlantic Avenue at Winthrop Avenue, Revere, on the 6-inch connection with the Revere distribution system, was installed June 16.

Insulating joint No. 21, located in Harvard Avenue, 200 feet south of Commonwealth Avenue, Brighton, on 12-inch blow-off pipe which connects with the Boston Water Works blow-off pipe at this place, was installed July 1.

Insulating joint No. 22, located in Chapel Street near Longwood Avenue, Brookline, on 48-inch low-service main, was installed November 19, during the construction of this pipe line.

Insulating joint No. 23, located at Beacon Street at Harvard Street, Brookline, on 36-inch connection with Boston Water Works 48-inch Beacon Street main, was installed December 3, during the construction of the pipe line.

All of these insulating joints have been installed so that the intensity of the electric currents flowing on the pipe line at these points can be measured and controlled, if desired. The cost of installing the joints was paid by the Metropolitan Water and Sewerage Board.

A comparison for the years 1907 and 1908 of the approximate average amount of electricity leaving the various pipe lines and flowing into the earth to cause damage to the pipes by electrolysis, in the districts where our investigations indicate that the most serious injury is being done, is as follows: —

DESCRIPTION OF PIPE LINE.	March and April, 1907 (Amperes).	June and July, 1908 (Amperes).	Maximum Cur- rent flowing at Any Point on Pipe Line in 1908 (Amperes).
Easterly 48-inch low service pipe line, Chestnut Hill Reservoir to Malden River.	70	150	170
Westerly 48-inch low-service pipe line, Chestnut Hill Reservoir to Mystic River.	105 ¹	190	150
42-inch low-service pipe line in Chelsea and Everett.	55 ¹	160	310
24-inch low-service pipe lines across Chelsea Creek,	5	-	-
16 inch high-service pipe line, Boston Avenue, Medford.	10	30	85
20-inch high-service pipe line in Stoneham, . . .	25	25	33
16-inch and 12-inch high-service pipe lines in Lynn,	50	45	34
12-inch high-service pipe line in Hyde Park, . . .	5	5	7
48-inch supply pipe line in Newton,	25	15	7

¹ Measurements made in October and November, 1907, show much larger currents leaving this pipe line.

The increased flow of electricity measured in October and November, 1907, on the westerly 48-inch low-service pipe line between the Chestnut Hill Reservoir and the Mystic River, and on the 42-inch low-service pipe line in Chelsea and Everett, has continued during the year, and a similar increase has been measured during the past year on the easterly 48-inch low-service pipe line between Chestnut Hill Reservoir and the Malden River. This large increase in the current leaving the pipe lines is a most unsatisfactory feature, especially as it now appears to be a permanent condition and is due in part to the failure of the rubber insulation in some of the insulating joints, and in part to an increase in the load on the railway system, and is not due to the temporary and erratic load conditions which sometimes occur while the measurements are being made.

The conditions on the other pipe lines show very little change from last year. No excavations have been made this year for the purpose of examining the pipe lines for electrolytic corrosion, but an examination of the easterly 48-inch low-service pipe line under the car tracks in Massachusetts Avenue, opposite Norfolk Street, in Cambridge, was made on July 20, while a joint leak was being repaired. A slight amount of electrolytic corrosion was discovered on the pipes at this point.

CLINTON SEWERAGE.

The Clinton sewage disposal works were in daily operation throughout the year. The quantity of sewage pumped to the filter-beds was 787,000 gallons per day, — a decrease of 80,000 gallons per day as compared with the preceding year. This decrease was undoubtedly due to the small amount of rainfall during the year, as the condition of the sewers in the town of Clinton is such that ground water in large quantities finds its way into the sewers after heavy rainfalls.

Following are statistics relating to the operation of the pumping station: —

Daily average quantity of sewage pumped (gallons), . . .	787,000
Daily average quantity of coal consumed (pounds), . . .	1,426
Gallons pumped per pound of coal,	552
Number of days pumping,	366
Cost of pumping: —	
Labor,	\$1,787 96
Fuel,	1,144 49
Repairs and supplies,	226 42
<hr/>	
Total for station,	\$3,158 87
Cost per million gallons pumped,	\$10 96
Cost per million gallons raised 1 foot high,	0 22

The cost of pumping was \$1,420.89 less than for the preceding year, due to reduction in the amounts paid for fuel and repairs.

Filter-beds.

The sewage was applied on the filter-beds in practically the same manner as during the latter half of 1907.

The eight settling basins into which the sewage is pumped, previously to being applied on the filter-beds, were used in rotation continuously throughout the year. During January, February, March and December two of the basins were used together for four weeks, when they were emptied and two others used. During the remainder of the year the basins were used in pairs for a period of one week, when they were drained off and cleaned. The prac-

tice of giving to the neighboring farmers the sludge accumulating in the settling basins was continued until August, and since then it has been used as fertilizer upon the lawns about the Wachusett Dam and the grassland on the rear slope of the South Dike.

The filter-beds have been used in rotation continuously throughout the year, each bed receiving a dose of 65,000 gallons in thirty minutes about once in two days. During previous years only five beds were used to care for the sewage during periods of extremely low temperature. During the past year, however, all of the beds were prepared with furrows 3 feet 6 inches apart, thus allowing their use in thirty-minute periods during the entire winter season, the same as in the summer time.

The results of the chemical analyses of the sewage and effluent are given in the following table: —

[Parts per 100,000.]

	1903.	1904.	1905.	1906.	1907.	January to June, 1908, inclusive.	July to December, 1908, inclusive.	Whole Year 1908.
Albuminoid ammonia, sewage.	.9233	.7967	1.1250	.8558	.8442	.4720	.6750	.5735
Albuminoid ammonia, effluent.	.0782	.0686	.0787	.0955	.0744	.0693	.0416	.0554
Per cent. removed, . . .	92	91	93	89	91	85	94	90
Oxygen consumed, sewage, .	8.65	8.57	13.11	9.84	7.87	2.94	3.93	3.43
Oxygen consumed, effluent, .	1.12	.99	1.126	1.34	1.07	0.94	0.58	0.765
Per cent. removed, . . .	87	88	91	86	87	68	85	78
Free ammonia, sewage, . .	3.8292	3.97	4.7533	3.5650	3.8342	3.5453	5.6933	4.6193
Free ammonia, effluent, . .	1.0185	.99	.9588	1.2723	1.3176	1.6067	1.1377	1.3722
Per cent. removed, . . .	73	75	80	64	66	55	80	70
Nitrogen as nitrates, effluent,	.4168	.4046	.2665	.1445	.1664	.0437	.2499	.1468

The analysis of effluent from these filter-beds has, for several years, indicated that the beds were gradually deteriorating in efficiency, and during the past two or three years the State Board of Health has been conducting investigations and experiments for the purpose of determining the cause and suggesting a remedy.

On August 7 the Board requested the State Board of Health to give its advice regarding the best method of improving the efficiency of the filters. On September 3 that Board reported that it was of the opinion that the size of the doses of sewage applied to the

beds previous to July, 1907, had been too large to permit of proper oxidation of the sewage, with the result that the filters had become clogged by the accumulation of organic matter in the interstices of the sand. The inefficiency of the filters was also thought to be partially due to uneven distribution of sewage on the surface of the filters, and to insufficient underdrainage. Upon the receipt of this advice immediate steps were taken to lay additional underdrains and to provide carriers for distributing the sewage. The laying of the underdrains was commenced on October 9 and continued until November 15, when work was suspended for the season. The work accomplished included the laying of two lines of 6-inch underdrains, aggregating 5,542 feet in length, under twelve of the twenty-four beds to be drained, the cleaning and relaying of 500 feet of 8-inch underdrain which had become clogged and useless, and the construction of the necessary manholes, lamp holes and outlet drains. This work was done at a cost of \$2,770.99. The completed plan provides for four lines of 6-inch vitrified pipe underdrain, equally spaced across each one-acre bed and laid at a depth of from 5 to 7 feet below the surface of the ground, and a sewage carrier extending about three-fourths of the distance across the bed from the centre of one side, constructed with a flat concrete bottom and vertical wooden sides, arranged with openings so as to get an equal distribution of the sewage over the entire bed. The area of the filter-beds is also to be increased by utilizing about three acres of the ground heretofore not available.

The cost of maintaining the filter-beds, exclusive of the cost of the work in connection with the laying of new underdrains, has been as follows:—

Labor,	\$3,050 12
Repairs and supplies,	97 06
<hr/>	
Total,	\$3,147 18
Cost per million gallons treated,	10 92

Daily tests of the sewage and effluent, to determine the amount of dissolved oxygen and iron, have been made by the keeper in charge of the beds.

ENGINEERING.

The greater portion of the time of the engineering force is now devoted to matters pertaining to the maintenance and operation of the works. The more important of these matters are the superintendence of the operation of the Venturi meters and of the flow of water from the several reservoirs through the aqueducts; the determination of the quantities of water used in the several municipalities; the tabulation of the records of rainfall as measured at twelve stations on the works, of the elevations of the several storage and distributing reservoirs, and of the pressures in the mains at different points in the Metropolitan District; the making of calculations to determine the yield of the several watersheds, the quantities delivered by the several aqueducts, the quantities pumped at the several pumping stations and the cost of pumping, the testing of coal and oil; and the examination of the pipes to determine the injury from electrolytic action.

Hydraulic measurements have been made to determine the loss of pressure in the mains, due to the tuberculation of the pipes. Official trials have been made of the pumping engines at the new Arlington station. Studies have been made for an addition to the pumping station in West Roxbury and for installing an additional pumping engine and boiler. Detail plans have been prepared for an ash hoist and storage bin at the Spot Pond pumping station. Record plans showing the pipes have been corrected to conform to changes made on the ground.

Appended to this report are tables of contracts giving the amount of work done and other information, a long series of tables relating to the maintenance of the Metropolitan Water Works, tables showing the length of main pipes and number of service pipes, meters and fire hydrants in the Metropolitan Water District, and a summary of statistics for 1908.

Respectfully submitted,

DEXTER BRACKETT,

Chief Engineer.

Boston, January 1, 1909.

REPORT OF CHIEF ENGINEER OF SEWERAGE WORKS.

To the Metropolitan Water and Sewerage Board.

GENTLEMEN:— The following is a report of the operations of the Engineering Department of the Metropolitan Sewerage Works for the year ending December 31, 1908.

ORGANIZATION.

The engineering organization during the year has been as follows:—

Division Engineers:—

FREDERICK D. SMITH, . . . *In charge of maintenance and construction, South Metropolitan System, in Quincy and Milton.*

FRANK I. CAPEN, . . . *In charge of maintenance and construction, North Metropolitan System and extension of the High-level Sewer in Brookline and Brighton.*

SETH PETERSON, . . . *In charge of construction, Section 80, including air tunnel, and of Section 81, South Metropolitan System.*

In addition to the above, there were employed at the end of the year 24 engineering and other assistants.

METROPOLITAN SEWERAGE DISTRICTS.

AREAS AND POPULATIONS.

During the year no changes have been made in the extent of the sewerage districts. The area of the North Metropolitan District remains at 90.50 square miles, and of the South Metropolitan District at 100.87 square miles, — a total, inclusive of water surfaces, of 191.37 square miles. These districts include the whole or parts of 25 cities and towns, as set forth in the following table.

The populations in the table are based on the census of 1905.

Table showing Areas and Estimated Populations within the Metropolitan Sewerage District, as of December 31, 1908.

		CITY OR TOWN.	Area (Square Miles).	Estimated Population.	
North Metropolitan District.	{	Arlington,	5.20	10,580	
		Belmont,	4.66	4,750	
		Boston (portions of),	3.45	96,680	
		Cambridge,	6.11	102,680	
		Chelsea,	2.24	31,600	
		Everett,	3.34	32,800	
		Lexington, ¹	5.11	4,350	
		Malden,	5.07	40,920	
		Medford,	8.35	21,590	
		Melrose,	3.73	15,230	
		Revere,	5.86	14,590	
		Somerville,	3.96	74,720	
		Stoneham,	5.50	6,690	
		Wakefield,	7.65	11,130	
		Winchester,	5.95	9,180	
South Metropolitan District.	{	Winthrop,	1.61	7,960	
		Woburn,	12.71	14,490	
				90.50	499,940
		Boston (portions of),	20.39	170,700	
		Brookline,	6.81	26,300	
		Dedham, ¹	9.40	7,900	
		Hyde Park,	4.57	15,350	
		Milton,	12.59	7,680	
		Newton,	16.88	40,800	
		Quincy,	12.56	30,960	
	{	Waltham,	13.63	28,350	
		Watertown,	4.04	12,450	
		100.87	340,490		
Totals,		191.37	840,430		

¹ Part of town.

METROPOLITAN SEWERS.

SEWERS PURCHASED AND CONSTRUCTED AND THEIR CONNECTIONS.

Within the Sewerage Districts there are now 101.35 miles of Metropolitan sewers. Of this total, 8.79 miles of sewers, with the Quincy pumping station, have been purchased from cities and towns of the districts, the remaining 92.56 miles of Metropolitan sewers and other works having been constructed by the Metropolitan boards.

The locations, lengths and sizes of these sewers are given in the following tables, together with other data referring to the public and special connections with the system:—

North Metropolitan System.

CITY OR TOWN.	Size of Sewers.	Length in Miles.	Public Connections, December 31, 1908.	SPECIAL CONNECTIONS.	
				Character or Location of Connection.	Number in Operation.
Boston:—					
Deer Island, .	6' 3" to 9',	1.367	4	-	-
East Boston, .	9' to 1',	5.467	23	Shoe factory,	1
Charlestown, .	6' 7"×7' 5" to 1',	3.292	14	Navy Yard,	8
				Almshouse,	1
				Club house,	1
Winthrop, . . .	9',	2.864	11	Fire Dept. Station,	1
				Private building,	1
				Bakery,	1
Chelsea,	8' 4"×9' 2" to 1' 10"×2' 4", .	5.123	9	Rendering works,	1
				Metropolitan Water Works blow-off,	1
				Metropolitan Water Works blow-off,	1
Everett,	8' 2"×8' 10" to 4' 8"×5' 1", .	2.925	6	Cameron Appliance Co.,	1
				Shultz-Goodwin Co.,	1
Malden,	4' 6"×4' 10" to 1' 3",	4.493 ¹	27	Metropolitan Water Works blow-off,	1
				Private buildings,	137
Melrose,	4' 6"×4' 10" to 10",	6.099 ²	34	Private buildings,	109
				Factory,	1
Cambridge, . . .	5' 2"×5' 9" to 1' 3",	7.167	31	Railroad station,	1
				Slaughter house,	1
				City Hospital,	2
				Tannery,	1
Somerville, . . .	6' 5"×7' 2" to 1' 10"×2' 3", .	3.471	10	Slaughter-houses (3),	1
				Car-house,	1
				Street railway power house,	1
				Stable,	1
				Rendering works,	1
Medford,	4' 8"×5' 1" to 10",	5.359	21	Armory building,	1
				Private buildings,	8
				Stable,	1
				Police sub-station,	1
				Tannery,	2
Winchester, . . .	2' 11"×3' 3" to 1' 3",	6.428	13	Private buildings,	2
				Gelatine factory,	1
				Stable,	1
Stoneham,	1' 3" to 10",	0.010	4	Railroad station,	1
Woburn,	1' 10"×2' 4" to 1' 3",	0.933	3	-	-
				Glue factory,	1

¹ Includes .988 of a mile of sewer purchased from the city of Malden.
² Includes .736 of a mile of sewer purchased from the city of Melrose.

North Metropolitan System — Concluded.

CITY OR TOWN.	Size of Sewers.	Length in Miles.	Public Connections, December 31, 1908.	SPECIAL CONNECTIONS.	
				Character or Location of Connection.	Number in Operation.
Arlington, . . .	1' 6" to 10", . . .	3.520 ¹	35 {	Private buildings, . . .	121
				Railroad station, . . .	1
				Car house, . . .	3
Belmont, ² . . .	- . . .	-	3	- . . .	-
Wakefield, ² . . .	- . . .	-	1	- . . .	-
Revere, . . .	4' to 3', . . .	0.048	2	- . . .	-
		58.566 ³	251		421

South Metropolitan System.

Boston (Back Bay),	6' 6" to 3' 9", . . .	1.500 ⁴	10 {	Tufts Medical School, . . .	1
				Private house, . . .	1
				Administration building, Boston Park Department, . . .	1
				Simmons College buildings, . . .	1
				Art Museum, . . .	2
Boston (Brighton),	5' 9"×6' 0" to 12", . . .	5.537 ⁵	11 {	Abattoir, . . .	3
				Chocolate works, . . .	2
Boston (Dorchester).	3'×4' to 2' 6"×2' 7", . . .	2.870 ⁶	10 {	Machine shop, . . .	1
				Paper mill, . . .	1
Boston (Roxbury),	6' 6"×7', 4' 0", . . .	1.430	-	Private buildings, . . .	2
Boston (West Roxbury).	9' 3"×10' 2" to 12", . . .	7.596	9 {	Parental school, . . .	1
				Lutheran Evangelical Church, . . .	1
Brookline, . . .	6' 6"×7' 0" to 5' 6", . . .	2.382	2	Private buildings, . . .	4
Dedham, . . .	4'×4' 1" to 3' 9"×3' 10", . . .	2.350	5	- . . .	-
Hull, . . .	60" pipe, . . .	0.750	-	- . . .	-
Hyde Park, . . .	10' 7"×11' 7" to 4'×4' 1", . . .	4.527	15 {	- . . .	-
				Mattapan Paper Mills, . . .	1
Milton, . . .	11'×12' to 8", . . .	3.600	11	Private buildings, . . .	2
Newton, . . .	4' 2"×4' 9" to 1' 3", . . .	2.911	6	- . . .	-
Quincy, . . .	11' 3"×12' 6" to 24" pipe, . . .	6.580	4	Private houses, . . .	2
Waltham, . . .	3' 6"×4', . . .	0.001	1	- . . .	-
Watertown, . . .	4' 2"×4' 9" to 12", . . .	0.750 ⁷	5	Factories, . . .	2
		42.784	89		28

1 Includes 2.631 miles of sewer purchased from the town of Arlington.
2 The Metropolitan sewer extends but a few feet into the towns of Belmont and Wakefield.
3 Includes 2.787 miles of Mystic River valley sewer in Medford, Winchester and Woburn, running parallel with the Metropolitan sewer.
4 Includes .355 of a mile of sewer purchased from the city of Boston.
5 Includes .026 of a mile of sewer purchased from the town of Watertown.
6 Includes 1.24 miles of sewer purchased from the city of Boston.
7 Includes .025 of a mile of sewer purchased from the town of Watertown.

COST OF CONSTRUCTION.

[To December 31, 1908.]

The cost of the 101.35 miles of Metropolitan sewers enumerated above, including seven stations, siphons and appertaining structures, may be summarized as follows:—

North Metropolitan System,	\$6,171,165 12
South Metropolitan System,	8,741,869 20
	<hr/>
	\$14,913,034 32

Information relating to areas, populations, local sewer connections and other data for the whole Metropolitan Sewerage District appear in the following table:—

North Metropolitan District.

Area (Square Miles).	Estimated Total Population.	Miles of Local Sewer connected.	Estimated Population contributing Sewage.	Ratio of Contributing Population to Total Population (Per Cent.).	CONNECTIONS MADE WITH METRO- POLITAN SEWERS.	
					Public.	Special.
90.50	499,940	639.50	424,050	84.8	251	421

South Metropolitan District.

100.87	340,490	492.86	201,595	59.2	89	28
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Entire Metropolitan District.

191.37	840,430	1,132.36	625,645	74.4	340	449
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Of the estimated gross population of 840,430 on December 31, 1908, 625,645, representing 74.4 per cent., were on that date contributing sewage to the Metropolitan sewers, through a total length of 1,132.36 miles of local sewers owned by the individual municipalities. These sewers are connected with the Metropolitan System by 340 public and 449 special connections. It appears, also, that there has been during the year an increase of 28.11 miles of local sewers connected with the Metropolitan System, and that 14 public and 26 special connections have been added.

PUMPING STATIONS AND PUMPAGE.

The following table shows the average daily volume of sewage lifted at each of the six Metropolitan pumping stations during the year, as compared with the corresponding volumes for the previous year:—

PUMPING STATION.	AVERAGE DAILY PUMPAGE.			
	Jan. 1, 1907, to Dec. 31, 1907.	Jan. 1, 1908, to Dec. 31, 1908.	Increase during the Year.	
	Gallons.	Gallons.	Gallons.	Per Cent.
Deer Island,	64,300,000	59,800,000	4,500,000	7.0 ¹
East Boston,	62,300,000	57,800,000	4,500,000	7.2 ¹
Charlestown,	32,600,000	31,300,000	1,300,000	4.0 ¹
Alewife Brook,	4,123,000	3,627,000	496,000	12.0 ¹
Quincy,	3,615,000	3,687,000	72,000	2.0
Ward Street (actual gallons pumped), .	21,200,000	22,300,000	1,100,000	5.2

¹ Decrease.

CONSTRUCTION.

NORTH METROPOLITAN SYSTEM.

Chapter 556 of the legislative Acts of 1908 provided an appropriation of \$445,000 for extensions and additions to the East Boston and Deer Island pumping stations.

Chapter 582 of the legislative Acts of 1908 provided \$40,000 for the restoration of the existing East Boston pumping station, damaged during the great Chelsea fire of April 12, 1908.

CONSTRUCTION AT DEER ISLAND STATION.

During the year concrete foundations for the engine house extensions of the Deer Island pumping station have been built by day labor, under the direction of the Engineer.

This engine house is located near the high-water line of the harbor, and to secure safe foundations below the peat and other vegetable deposits on the shore these foundations were extended to a depth of about 15 feet below the general surface of the ground at the engine house, which is about elevation 116. The foundations are of Portland concrete, about 4 feet in thickness. On the northerly side of the house the extension is to rest on the existing outfall sewer, and the foundation was extended to the roof of this sewer, which was substantially reinforced with concrete and steel.

A chamber for placing a 60-inch cast-iron discharge pipe, with valve chamber, Venturi meter chamber and controlling manholes at the outfall sewer, has been constructed in connection with this work.

The foundations for this extension are now fully completed in condition for building the superstructure during the coming spring. Detailed plans for superstructures of the extensions of the engine and coal houses have been prepared during the year and contracts for the construction are now being arranged, which contemplate that work on these buildings will be started as early as April 1 and completed by September 1.

The buildings are to be of brick, with trimmings and stone work in agreement with the architectural lines of the existing station. The engine house extension will be 50 feet long by 46 feet wide. The coal house extension will be 103 feet long and 35 feet wide.

The existing road which passes the extension of the engine house has been moved about 10 feet nearer the harbor, and to defend this road against the tide wash during high seas, the granite wall along the sea side of the highway fronting the engine house has been extended about 150 feet. The heel of this wall has been defended by heavy riprap. This work has also been carried out by day labor under the direction of the Engineer.

On November 2 a contract was arranged with the Allis-Chalmers Company of Milwaukee for furnishing and erecting at the Deer Island station one one-hundred-million-gallon pump and engine, four boilers, economizer, piping and appurtenances. This additional pumping plant is to be in place for service within two years of the date of the contract.

The contract provides that the pump shall be of the same general heavy and slow-running, centrifugal type as that already installed at the station. The boilers are to be of the internally fired, horizontal, tubular type, from designs by F. W. Dean, Mechanical Engineer.

CONSTRUCTION AT EAST BOSTON STATION.

On the afternoon of Sunday, April 12, the great Chelsea fire reached the shores of Chelsea Creek, near the East Boston pumping station, by the middle of the afternoon. The fire service at the station defended the property until about 5 P.M. At that time a barge of inflammable material on the creek near the oil works exploded, and the flames were carried by the incoming tide up to and around the station. The flames mounted up the sides of the station to the roof, and in a few minutes the doors, windows, roof, coal house and wharf were a mass of flames.

The pumping service at the station was abandoned about 5.30 P.M. The Charlestown pumping station was also shut down about 10 P.M. and remained shut down until April 17.

During the night many of the larger combined sewers were sealed off from the Metropolitan System and the discharge from them turned into the harbor.

On Monday, April 13, and later, the overflows in the Metropolitan Sewer were raised to about elevation 107, and this arrangement resulted in forcing through the pumps and passages of the abandoned station from 18,000,000 to 25,000,000 gallons of sewage per day, or about one-half the ordinary quantity pumped at this station in dry weather. This probably provided for all sewage from separate systems connected with the works and some sewage from a few of the more offensive of the connections with combined systems.

The fire entirely destroyed roofs, doors, windows, coal house and wharf at this station. The girders and most of the piping of the station were a mass of twisted iron and steel. The walls were scarred and cracked and had fallen in places.

An examination of the building by experts indicated that the foundations and walls were safe to cover with a light, temporary roof. An examination of the machinery indicated that pumps, steam cylinders and boilers had not been greatly injured.

Between April 13 and April 27 a temporary wooden roof, doors and windows were placed by Woodbury & Leighton, builders. While the temporary roof was being placed, necessary repairs to one engine, piping and two boilers were made by the engineers of the works. One engine was started on the afternoon of April 26, just two weeks after the date of the fire, and since that date the service of the station and works has been normal.

A second engine and second pair of boilers were started on May 8, one week after the first, and the third engine and last pair of boilers were fully repaired and ready for service on June 3.

Of the \$40,000 appropriated for repairs to this station by chapter 582, Acts of 1908, about \$20,000 remains, which will doubtless provide a permanent roof, doors, windows, etc., when the details for the permanent rebuilding of this station have been fully developed.

Chapter 556, Acts of 1908, authorized an expenditure of \$250,000 for extensions to existing buildings and an additional engine and new boilers at this station.

At the date of this report the details of the future development at this station have not been fully determined, so that no construction authorized by chapter 556 of the Acts of 1908 has yet been carried out.

SOUTH METROPOLITAN SYSTEM.

EXTENSION OF THE HIGH-LEVEL SEWER THROUGH WEST ROXBURY, BROOKLINE AND BRIGHTON.

This extension, authorized by chapter 406 of the Acts of 1906, involving a length of 5.64 miles of main sewers, varying from 7 feet to 5 feet in diameter, is practically completed at the date of this report. Of the seven sections into which it has been divided for purposes of construction and record, five have been fully completed. On the other two about 145 feet remain to be completed. It is anticipated that this work will be fully completed by the middle of February.

Section 80, West Roxbury and Brookline.

Division Engineer in Charge. — SETH PETERSON.

Superintendent of Construction by Day Labor. — CHARLES A. HASKIN.

This section was completed on July 30, 1908. It was constructed largely in tunnel by pneumatic process, by day labor, under the direction of Charles A. Haskin, pneumatic expert.

The section is 3,123 feet in length. For a distance of about 204 feet, at the westerly end, it was found that the sewer would be built in dry sand and gravel at a depth of about 22 feet below the surface of the street. This length of 204 feet was, by action of the Board, added to the contract for Section 81, and was constructed in open trench by Bruno & Petitti, between May 18 and July 30, 1908.

The excavation was in dry sand and gravel. The masonry section was of the horseshoe type, 7 feet by 6 feet 6 inches in diameter. The walls of the sewer are of Portland concrete, about 15 inches in thickness.

The length of pneumatic tunnel constructed on this section is 2,919 feet. At the date of the last report, 2,560 feet of headings had been completed. The remaining 359 feet, largely in rock and in part rock and earth headings, were driven between January 1 and May 20, when the headings were completed.

At the date of the last report 2,215 feet of the masonry lining of the tunnel had been placed, — 885 feet in the easterly headings and 1,330 feet in the westerly heading. The 314 feet of masonry lining

placed during the year in the westerly heading is of circular cross-section, 7 feet in diameter, with walls not less than 12 inches in thickness. In the easterly heading the masonry last year had been built into the solid rock. No masonry was placed this year in this heading until it had been blasted through to its connection with the branch at the bellmouth in Centre Street. During the year 401 feet of this heading in Roxbury pudding-stone has been lined with Portland cement concrete. The tunnel headings were about 10 feet in diameter and the finished diameter of the sewer 7 feet, making the walls for this length about 18 inches in thickness.

The masonry shaft on Perkins Street, about 475 feet east of Jamaicaaway, from which the tunnel excavation has been made, has been completed with masonry to the surface, finished with standard iron cover, and left in condition to be used for ventilation or in cleaning this length of tunnel.

Section 81, Brookline.

Division Engineer in Charge. — SETH PETERSON.

Contractors. — BRUNO & PETITTI, Contract No. 60 (Sta. 0 to 21 + 40). HUGH NAWN CONTRACTING COMPANY, Contract No. 61 (Sta. 21 + 40 to 34 + 15).

This section extends from near the boundary line between West Roxbury and Brookline, near the junction of Chestnut Street and Pond Avenue, along Chestnut, Kendall and Cypress streets to Boylston Street, in Brookline, — a distance of 3,415 feet.

Two contracts were made for this construction previous to the date of the last report; one, with Bruno & Petitti, extending from the town line along Chestnut and Kendall streets, — a distance of 2,140 feet.

Work was started on this contract on March 3, 1908. The excavation was to an average depth of about 21 feet from the surface to the bottom of the masonry.

The excavation for the first 200 feet was in sand and gravel; and for the next 600 feet in sand and gravel with boulders, and with ledge in the bottom for about 125 linear feet, having an average depth of about 3 feet.

From about 150 linear feet northerly from High Street for 1,000 feet, near the corner of Chestnut and Kendall streets, the excavation was in sand, gravel and clay, with rock in the bottom for about 325 linear feet.

For about 150 linear feet, near the corner of Chestnut and Kendall streets, fine yellow sand extended nearly to grade; below this was sand and gravel. For the remainder of the contract, through Kendall Street, the excavation was in sand, clay and gravel, with rock in the bottom for the last 130 feet extending from 0 to 8 feet in depth. No large amount of ground water was encountered; a four-inch centrifugal pump, operated automatically by electricity, ran about one-half of the time.

A bucket excavator was used on the work through Chestnut Street and for about one-half of the length of Kendall Street; for the remaining distance on Kendall Street an "A" frame derrick was used. The work with this derrick was started on July 6, 1908, and the last 200 feet of the section was excavated by this method.

In April, 204 linear feet of Section 80 were added to the contract of Bruno & Petitti, as previously mentioned in this report. The work on this additional 204 feet was started on May 18 and finished about July 20. This contract was finished on December 8, 1908. Owing to severe weather conditions at this season of the year the resurfacing of the streets has been left until spring.

As noted in the last report, a second contract on this section, extending from Kendall Street through Cypress Street to Boylston Street, a distance of 1,275 feet, was made with the Hugh Nawn Contracting Company.

Work on this contract had been commenced at the time of the last report, and 130 linear feet of trench excavated near Boylston Street. A tunnel shaft had then been excavated at the corner of Cypress and Kendall streets and a heading started.

A second shaft was started on January 10, 1908, about 200 feet north from Walnut Street, and a tunnel heading started to meet the heading from the shaft at the corner of Cypress and Kendall streets; these headings were driven through rock. The open cut from Boylston Street was continued to meet the shaft near Walnut Street, with the exception of about 50 feet which was tunnelled, passing some trees near Milton Road, and under three water pipes, and the car tracks in Boylston Street. The excavation for the open cut was in sand, clay and gravel, with rock for the last 7 feet.

A small amount of water was encountered on this section, estimated at 150,000 gallons per day.

The work was completed on August 15, 1908.

Section 82, Brookline.

Division Engineer in Charge. — FRANK I. CAPEN.

Contractors. — T. J. O'CONNELL, Contract No. 57 (Sta. 0 + 30 to 13 + 50). T. J. O'CONNELL, Contract No. 55 (Sta. 30 + 50 to 48 + 50). JAMES DRISCOLL & SON, Contract No. 56 (Sta. 13 + 50 to 30 + 50).

This section extends from Boylston Street, along Cypress Street, Brington Road, private lands, Brookline Playground, Davis and Gorham avenues, Greenough, Washington and Park streets, to Beacon Street, — a distance of 4,830 feet.

This section was practically completed at the date of the last annual report.

There remained to be completed the resurfacing of streets and sidewalks on the three contracts. This was finished during the months of March and April.

Section 83, Brookline.

Division Engineer in Charge. — FRANK I. CAPEN.

Contractors. — CHARLES G. CRAIB & Co., Contract No. 54 (Sta. 16 + 64 to 24 + 64). T. J. O'CONNELL, Contract No. 62 (Sta. 0 to 16 + 64).

As noted in the last report, two contracts were arranged for construction; one, with Charles G. Craib & Co., for a length of 800 feet, completed previous to January 1, 1908, and discussed in the last report.

On the second contract, that with T. J. O'Connell, for a length of 1,664 feet, work had been started at three tunnel shafts at that date; one, at Beacon Street, a heading extending northerly across Beacon Street toward Winchester Street, had been excavated 66 feet. This was continued for 422 linear feet and met a heading driven southerly from a shaft about 800 feet north of Beacon Street in Winchester Street, which had advanced 30 feet on January 1, 1908. The distance between these shafts is about 800 feet.

A heading northerly from this shaft had advanced 30 feet, and one from a shaft near Fuller Street 25 feet southerly. Work was continued in both these headings until they met on May 6.

The length of tunnel driven since the last report is 1,484 feet.

The excavation northerly from the shaft at Beacon Street was through dry sand for 400 feet. For the remainder of the distance to the shaft, near Fuller Street, the excavation was in sand and

gravel, with clay at either the bottom or roof for nearly the entire distance; but a small amount of water was encountered. The masonry lining was of Portland concrete, with a minimum thickness of 12 inches. The headings were not allowed to be driven over 30 feet in advance of the masonry lining. About 50 linear feet of the masonry had been placed on January 1, 1908; masonry was finished on May 22.

Section 84, Brookline and Brighton.

Division Engineer in Charge. — FRANK I. CAPEN.

Contractor. — D. F. O'CONNELL, Contract No. 53.

This section extends from near Winchester Street, through private lands and Columbia Street in Brookline, and in Harlan Street, private lands and Commonwealth Avenue in Brighton, to near Allston Street, — a distance of 2,168 feet.

This section was fully completed prior to the date of this report.

Section 85, Brighton.

Division Engineer in Charge. — FRANK I. CAPEN.

Superintendent of Construction by Day Labor. — CHAS. A. HASKIN (Sta. 0 to 11 + 42).

Contractors. — GEO. M. BRYNE COMPANY, Contract No. 63 (Sta. 11 + 42 to 24 + 00). D. F. O'CONNELL COMPANY, Contract No. 64 (Sta. 24 + 00 to 47 + 00). HUGH NAWN CONTRACTING COMPANY, Contract No. 65 (Sta. 47 + 00 to 63 + 50).

This section extends from near Allston Street, along Commonwealth Avenue, Warren, Cambridge and Washington streets, to near Lake Street, — a distance of 6,350 feet. The lower portion of this section was constructed by the Board by day labor. Three contracts have been made for the construction of the remainder of the section.

As stated in the last report, the portion of this section constructed by day labor was completed previous to that date.

Actual work on the contract for the portion of the section in Warren Street, 1,258 feet in length, George M. Bryne Company, contractors, had not been commenced. Work was started on the excavation of a shaft, about 12 feet square, near the middle of the contract on January 2, 1908. This was to grade February 7, 1908, and headings were started in either direction on February 10, 1908. The westerly heading was completed on May 20, and the easterly heading on May 28. The tunnel has been lined with Portland concrete, with a minimum thickness of 12 inches; the finished section

is 6 feet high by 5 feet 9 inches wide. The masonry lining was started on May 26, 1908, and completed on July 27, 1908. The manhole at the shaft was completed on August 10. The excavation of the tunnel was through solid rock for the entire distance and but little water was encountered.

At the date of the last report, under the contract with the D. F. O'Connell Company, for a portion of the section in Warren, Cambridge and Washington streets, 2,300 feet in length, a shaft near the middle of the section had been excavated to a depth of 38 feet. This shaft was excavated to grade on January 15, 1908.

A heading was started westerly from this shaft on January 30, and easterly on February 3. The east heading was finished on August 1. Excavation in the west heading was stopped on August 18 on account of losing the rock in the roof of the tunnel heading about 70 feet from the end of the contract, and the driving was postponed until the masonry lining was placed to near this point. Work in the heading was resumed on October 27 and finished on November 30.

The masonry lining in the east heading was commenced on September 3 and in the west heading on September 21. The tunnel was lined with Portland concrete.

The finished section is of the horseshoe shape, 6 feet high by 5 feet 9 inches wide. The lining has a minimum thickness of 12 inches. The concrete was finished, except for about 30 feet near the shaft, on December 31. This will probably be finished and a shaft manhole built during January of 1909.

For the entire length of tunnel, except for about 200 feet, the excavation has been in solid rock. For this 200 feet the tunnel had an earth roof requiring timbering. Of this length, 40 feet were wholly in earth. It is estimated that the maximum amount of water pumped at the central shaft has been about 300,000 gallons per twenty-four hours.

Work on the contract made with the Hugh Nawn Contracting Company for the portion of the section in Washington Street, for 1,650 linear feet, was started previous to January 1, 1908. A shaft about 200 feet west from Foster Street had been excavated to a depth of 42 feet. This shaft was excavated to grade on January 14, and a heading started westerly on January 25 and easterly on January 29. These headings were finished on May 16 and 12, respectively.

A second shaft was started just easterly from Foster Street on February 25, and excavated to grade on March 24. Headings were started in either direction on April 2. The westerly heading was finished on May 12. The masonry lining of that portion of the tunnel between the second shaft and the easterly end of the contract was started on May 23, and finished on July 17. The driving of the easterly heading from the second shaft was through wet sand and gravel with some clay. On June 23 the driving from this shaft was stopped when the heading had advanced well into solid rock. This heading was lined with masonry, and the excavation in the rock heading again started on July 16 and continued until completed on October 10. The masonry lining was finished on November 23 and the shaft backfilled on November 28.

The excavation for this contract was in solid rock for 1,040 linear feet, in sand and gravel for 400 linear feet, and part rock and part earth for 210 linear feet. The masonry lining is of Portland concrete, of horseshoe cross-section, 5 feet 9 inches wide by 6 feet high, with a minimum thickness of 12 inches. It is estimated that the maximum amount of ground water pumped per twenty-four hours was 300,000 gallons.

Section 86, Brighton.

Division Engineer in Charge.—FRANK I. CAPEN.

Contractors.—GLENN & BRODERICK, Contract No. 66, for 1,650 linear feet of 12-inch pipe sewer and 715 linear feet of 42-inch concrete sewer. CHARLES J. JACOBS COMPANY, Contract No. 67, for 1,305 linear feet 69-inch by 72-inch concrete sewer and 1,135 linear feet 72-inch by 48-inch reinforced concrete sewer.

This section extends westerly through Washington Street from a point about 200 feet east of Lake Street to Nonantum Street, at Oak Square, — a distance of 2,440 linear feet.

A portion of this section of the Metropolitan Sewer is located so near the surface as to interfere with some of the local sewers of the city of Boston. On this account it was necessary to construct a sewer on either side of Washington Street, for a portion of the length of this section, for the use of the city of Boston.

At Lake Street a 36-inch by 38½-inch city sewer crossed the line of the proposed Metropolitan Sewer. To avoid interfering with the city sewer a new 42-inch concrete sewer was laid, at a lower and flatter grade, from Lake Street to Fairbanks Street, on the northerly

side of Washington Street. The roof of the Metropolitan Sewer, crossing low territory above Lake Street to near Oak Square, is at such an elevation as to cut off house connections with local sewers on the southerly side of Washington Street. A 12-inch pipe sewer was built south of the Metropolitan Sewer for a length of 1,650 feet.

A contract for the construction of these relief sewers was made with Glenn & Broderick on June 24, 1908. Work was started on the 12-inch pipe sewer on June 30 and finished on July 29. The construction of the 42-inch sewer was started on July 31 and finished on December 21. The excavation of the trench for the 12-inch pipe was in sand and gravel, with clay, for a few hundred feet west of Brackett Street. The average cut was about 10 feet for the 12-inch pipe and 18 feet for the concrete sewer, and very little water was encountered. The 42-inch sewer was carried under the invert of the Metropolitan Sewer at Lake Street by two 24-inch cast-iron pipes surrounded by concrete. The walls of the concrete sewer were of 8-inch Portland concrete. House branches were built into both sewers about 25 feet apart.

A contract for the construction of the main sewer for this section was made with the Charles J. Jacobs Company on August 4, 1908. This was for 1,305 linear feet of 69-inch by 72-inch Portland concrete sewer, with minimum thickness of masonry 12 inches, and 1,135 linear feet of 72-inch by 48-inch sewer, with Portland concrete invert and 8-inch brick arch, covered with 6 inches of Portland concrete.

This latter section extends from a point about 400 feet east of Fairbanks Street to Brackett Street. The top of the sewer is from 3 to 4 feet below the street surface. The masonry is reinforced with $5/8$ -inch twisted steel bars.

The average cut for the whole contract was about 14 feet. The excavation was in sand, gravel and clay, with rock in the bottom for about 100 feet near the beginning of the contract; above this rock many large boulders were found.

Work on this contract was started at Nonantum Street, Oak Square, on August 11, and continued easterly to a point about 200 feet east of Fairbanks Street, and was finished on November 18. A second opening was started about 200 feet east of Fairbanks Street on October 9 and continued easterly. On January 1 the work remaining comprised about 70 linear feet of trench excavation and

the placing of the masonry for a length of 113 feet. Very little water has been encountered. A hand pump has been used for short distances at different parts of the work.

MAINTENANCE.

SCOPE OF WORK AND FORCE EMPLOYED.

The maintenance of the Metropolitan Sewerage System includes the operation of 7 stations and 101.35 miles of Metropolitan sewers, receiving the discharge from 1,132.36 miles of town and city sewers at 340 points, together with the care and study of inverted siphons under streams and in the harbor.

The permanent maintenance force of 145 men includes 87 engineers and other employés at the pumping stations, and 58 men employed on actual sewer maintenance and care of pumping station grounds. In the following three tables the use of the completed systems and other data are shown: —

NORTH METROPOLITAN SYSTEM.

Table showing Cities and Towns delivering Sewage in this System; Approximate Miles of Sewer connected; Estimated Populations and Areas now contributing; Total Areas ultimately to contribute, and Present Populations on Such Areas; Ratios of Present Contributing Areas to Ultimate Areas, and Ratios of Populations now contributing to Present Total Populations.

[Populations estimated as of December 31, 1908.]

CITIES AND TOWNS.	Miles of Local Sewer connected.	Separate or Combined.	Number of Connections with Local Sewers.	Estimated Number of Persons served by Each House Connection. ¹	Estimated Population now contributing Sewage.	Estimated Present Total Population.	Estimated Area now contributing Sewage.	Area ultimately to contribute Sewage.	Ratio of Contributing Population to Present Total Population.	Ratio of Contributing Area to Ultimate Area.
Boston (Deer Island),	0.70	Separate,	—	—	1,510 ²	1,510 ²	Square Miles.	Square Miles.	Per Cent.	Per Cent.
Winthrop,	28.47	Separate,	2,098	3.70	7,760	7,960	1.24	1.61	100.00	77.0
Boston (East Boston),	29.07	Separate and combined,	4,283	12.10	51,825	55,050	1.05	2.18	97.50	97.50
Chelsea,	28.97 ³	Separate and combined,	2,805	9.00	25,245	31,600	1.09	2.24	94.10	48.2
Everett,	42.72	Separate and combined,	4,125	6.40	26,400	32,800	1.88	3.34	79.90	48.7
Malden,	50.98	Separate,	5,004	5.60	28,020	40,920	2.65	5.07	90.50	56.3
Melrose,	35.09	Separate,	2,693	4.40	11,455	15,230	1.73	3.73	68.50	52.3
Boston (Charlestown),	21.16	Separate and combined,	5,222	7.65	39,950	40,120	0.67	1.27	75.20	46.4
Cambridge,	139.65	Separate and combined,	14,953	6.75	100,930	102,680	4.94	6.11	99.60	52.8
Somerville,	92.09	Separate and combined,	13,755	5.35	73,590	74,720	3.30	8.35	98.30	80.9
Medford,	50.77	Separate,	3,662	5.50	20,140	21,590	2.71	3.96	98.50	83.3
Winchester,	22.76	Separate,	1,112	5.50	6,115	9,180	1.11	5.95	93.30	32.5
Woburn,	13.50 ⁵	Separate,	1,010	5.40	5,455	14,490	0.93	12.71	66.60	18.7
Stoneham,	11.47	Separate,	669	4.50	3,010	6,690	0.62	5.50	37.60	7.3
Arlington,	20.42	Separate,	1,110	6.10	6,770	10,580	1.66	5.20	45.00	11.3
Belmont,	12.22	Separate,	427	5.90	3,000 ⁶	4,750	1.01	4.66	64.00	31.9
Wakefield,	11.20	Separate,	468	5.60	2,620	11,130	0.42	7.65	63.20	21.7
Lexington, ⁷	—	—	—	—	—	4,370	—	5.11	23.50	5.5
Revere,	28.26	Separate,	2,051	5.00	10,255	14,590	1.63	5.86	70.30	27.8
Totals,	639.50	—	65,357	6.50	424,050	499,940	28.64	90.50	84.80	31.6

¹ Estimated from assessors' statement of the number of houses in each city or town, and the population from census of 1905 extended to May 1, 1908.

² Estimated by Superintendent James H. Cronin of the Institution on Deer Island.

³ The districts connecting at Cypress Street, Revere Beach Parkway, Springvale Avenue, Willoughby, Bellingham, Highland, Hawthorn and Spruce streets are now contributing sewage.

⁴ Estimated.

⁵ Exclusive of Mystic River valley sewer and tanneries.

⁶ Including 2 connections with McLean Hospital, having an estimated population of 480.

⁷ Lexington not connected.

SOUTH METROPOLITAN SYSTEM.

Table showing Cities and Towns delivering Sewage to this System; Approximate Miles of Sewer connected; Estimated Populations and Areas now contributing; Total Areas ultimately to contribute, and Present Populations on Such Areas; Ratios of Present Contributing Areas to Ultimate Areas, and Ratios of Populations now contributing to Present Total Populations.

[Populations estimated as of December 31, 1908.]

CITIES AND TOWNS.	Miles of Local Sewer connected.	Separate or Combined.	Number of Connections with Local Sewers.	Estimated Number of Persons served by Each House Connection. ¹	Estimated Population now contributing Sewage.	Estimated Present Total Population.	Estimated Area now contributing Sewage.	Area ultimately to contribute Sewage.	Ratio of Contributing Population to Present Total Population.	Ratio of Contributing Area to Ultimate Area.
Boston (Back Bay), .	22.90	Separate and combined,	1,571	20.4	32,050	32,300	Square Miles. 1.21	Square Miles. 1.61	Per Cent. 99.2	Per Cent. 75.2
Boston (Brighton), .	54.20	Separate and combined,	2,790	6.1	17,020	25,050	3.16	3.74	67.9	84.5
Brookline, . . .	59.71	Separate and combined,	3,339	7.5	25,040 ²	26,300	3.26	6.81	95.2	47.9
Newton, . . .	105.45	Separate, . . .	5,467	6.1	33,350	40,800	6.99	16.88	81.7	41.4
Watertown, . . .	33.82	Separate, . . .	1,725	5.4	9,315	12,450	1.87	4.04	74.8	46.3
Waltham, . . .	42.74	Separate, . . .	3,340	7.85 ²	26,220	28,350	2.19	13.63	92.5	16.1
Boston (Dorchester), .	33.89	Separate and combined,	2,221	6.7	14,880	49,250	1.58	4.89	30.2	32.3
Milton, . . .	7.70	Separate and combined,	311	5.4	1,680	7,680	0.40	12.59	21.9	3.2
Hyde Park, . . .	23.83	Separate, . . .	1,245	7.9 ²	9,835	15,350	1.18	4.57	64.1	25.8
Dedham, . . .	14.39	Separate, . . .	433	4.9	2,120	7,900 ³	0.73	9.40	26.8	7.8
Boston (Roxbury), .	-	-	-	-	-	34,650	-	1.23	-	-
Boston (West Roxbury),	41.68	Separate, . . .	2,227	6.7	15,980 ⁴	29,450	2.01	8.92	54.3	22.5
Quincy, . . .	52.55	Separate, . . .	2,612	5.4	14,105	30,960	2.54	12.56	45.6	20.2
Totals, . . .	492.86	-	27,281	7.4	201,595	340,490	27.12	100.87	59.2	26.9

¹ Estimated from assessors' statement of the number of houses in each city or town, and the population from census of 1905 extended to May 1, 1908.

² Estimated by City Engineer.

³ Part of town not included in Metropolitan Sewerage District.

⁴ Including connection with Institution at Austin Farm having an estimated population of 945.

WHOLE METROPOLITAN SYSTEM.

Table showing Areas delivering Sewage to the Entire System, inclusive of Added High-level Area; Approximate Miles of Sewer connected; Estimated Populations and Areas now contributing; Total Areas ultimately to contribute, and Present Populations on Such Areas; Ratios of Present Contributing Areas to Ultimate Areas, and Ratios of Populations now contributing to present Total Populations.

[Populations estimated as of December 31, 1908.]

SYSTEM.	Miles of Local Sewer connected.	Separate or Combined.	Number of Connections with Local Sewers.	Estimated Number of Persons served by Each House Connection.	Estimated Population now contributing Sewage.	Estimated Present Total Population.	Estimated Area now contributing Sewage.	Area ultimately to contribute Sewage.	Ratio of Contributing Population to Present Total Population.	Ratio of Contributing Area to Ultimate Area.
North Metropolitan,	639.50	Separate and combined,	65,357	6.5	424,050	499,940	Square Miles. 28.64	Square Miles. 90.50	Per Cent. 84.8	Per Cent. 31.6
South Metropolitan,	492.86	Separate and combined,	27,281	7.4	201,595	340,490	27.12	100.87	59.2	26.9
Totals, . . .	1132.36	- - -	92,638	6.8	625,645	840,430	55.76	191.37	74.4	29.1

CAPACITY AND RESULTS.

The following tables summarize the pumping records for the year for the Metropolitan sewerage stations:—

NORTH METROPOLITAN SYSTEM.

Deer Island Pumping Station.

At this station are three submerged centrifugal pumps, with impellers or wheels 8.25 feet in diameter, driven by triple-expansion engines of the Reynolds-Corliss type.

Contract capacity of pumps: 45,000,000 gallons each, with 19-foot lift.
Average duty for the year: 50,800,000 foot-pounds.
Average quantity raised each day: 59,800,000 gallons.
Force employed: 4 engineers, 4 firemen, 3 oilers, 3 screenmen and 1 relief screenman.
Coal used: first-quality Cumberland, costing from \$4.15 to \$4.98 per gross ton.

Table of Approximate Quantities, Lifts and Duties at the Deer Island Pumping Station of the North Metropolitan System.

MONTHS.	Total Pumpage (Gallons).	Average per Day (Gallons).	Minimum Day (Gallons).	Maximum Day (Gallons).	Average Lift (Feet).	Average Duty (ft.-lbs. per 100 lbs. Coal).
1908.						
January,	2,468,900,000	79,600,000	58,900,000	105,000,000	11.02	56,800,000
February,	2,470,000,000	85,200,000	65,300,000	109,900,000	11.26	52,500,000
March,	2,405,200,000	77,600,000	64,200,000	107,400,000	11.01	54,600,000
April,	2,013,000,000 ¹	67,100,000 ¹	60,300,000 ¹	71,000,000 ¹	10.35 ¹	52,600,000 ¹
May,	1,852,500,000	59,800,000	47,000,000	83,400,000	10.61	55,600,000
June,	1,619,400,000	54,000,000	48,000,000	64,500,000	10.16	51,100,000
July,	1,565,300,000	50,500,000	42,600,000	75,500,000	10.16	49,700,000
August,	1,615,000,000	52,100,000	42,300,000	74,300,000	10.41	50,900,000
September,	1,489,700,000	49,700,000	41,800,000	63,600,000	10.16	50,700,000
October,	1,480,700,000	47,800,000	38,800,000	96,000,000	10.44	45,000,000
November,	1,324,700,000	44,100,000	36,600,000	55,600,000	10.31	44,700,000
December,	1,555,300,000	50,200,000	37,800,000	75,200,000	10.14	45,300,000
Total,	21,859,700,000	-	-	-	-	-
Average,	-	59,800,000	48,600,000	81,800,000	10.50	50,800,000

¹ Approximate only. On account of the Chelsea fire the pumping service of this station was largely reduced from April 12 to 26. The quantities, lift and duty for the month of April have been estimated.

East Boston Pumping Station.

At this station are three submerged centrifugal pumps, with impellers or wheels 8.25 feet in diameter, driven by triple-expansion engines of the Reynolds-Corliss type.

Contract capacity of pumps: 45,000,000 gallons each, with 19-foot lift.

Average duty for the year: 50,000,000 foot-pounds.

Average quantity raised each day: 57,800,000 gallons.

Force employed: 4 engineers, 4 firemen, 3 oilers, 3 screenmen, 1 relief screenman and 3 helpers.

Coal used: first-quality Cumberland, costing from \$3.69 to \$4.98 per gross ton.

Table of Approximate Quantities, Lifts and Duties at the East Boston Pumping Station of the North Metropolitan System.

MONTHS.	Total Pumpage (Gallons).	Average per Day (Gallons).	Minimum Day (Gallons).	Maximum Day (Gallons).	Average Lift (Feet).	Average Duty (ft.-lbs. per 100 lbs. Coal).
1908.						
January,	2,406,900,000	77,600,000	56,900,000	103,000,000	17.00	56,500,000
February,	2,412,000,000	83,200,000	63,300,000	107,900,000	17.11	54,700,000
March,	2,343,200,000	75,600,000	62,200,000	105,400,000	17.10	57,700,000
April,	1,953,000,000 ¹	65,100,000 ¹	58,300,000 ¹	69,000,000 ¹	16.82 ¹	-
May,	1,790,500,000	57,800,000	45,000,000	81,400,000	14.07	-
June,	1,559,400,000	52,000,000	46,000,000	62,500,000	15.25	-
July,	1,503,300,000	48,500,000	40,600,000	73,500,000	15.42	48,900,000
August,	1,553,000,000	50,100,000	40,300,000	72,300,000	15.13	46,200,000
September,	1,429,700,000	47,700,000	39,800,000	61,600,000	15.46	46,000,000
October,	1,418,700,000	45,800,000	36,800,000	94,000,000	15.65	50,200,000
November,	1,264,700,000	42,100,000	34,600,000	53,600,000	15.46	44,100,000
December,	1,493,300,000	48,200,000	35,800,000	73,200,000	15.47	45,800,000
Total,	21,127,700,000	-	-	-	-	-
Average,	-	57,800,000	46,600,000	79,800,000	15.83	50,000,000

¹ Approximate only. On account of the Chelsea fire the pumping at this station was abandoned from April 12 to 26. The quantities, lift and duty for the month of April have been estimated.

Charlestown Pumping Station.

At this station are three submerged centrifugal pumps, two of them having impellers or wheels 7.5 feet in diameter, the other 8.25 feet in diameter. They are driven by triple-expansion engines of the Reynolds-Corliss type.

Contract capacity of pumps: two, 22,000,000 gallons each, with 11-foot lift; one, 60,000,000 gallons, with 8-foot lift.

Average duty for the year: 52,200,000 foot-pounds.

Average quantity raised each day: 31,300,000 gallons.

Force employed: 4 engineers, 4 firemen, 3 oilers, 3 screenmen and 1 relief screenman.

Coal used: first-quality Cumberland, costing from \$3.815 to \$4.98 per gross ton.

Table of Approximate Quantities, Lifts and Duties at the Charlestown Pumping Station of the North Metropolitan System.

MONTHS.	Total Pumpage (Gallons).	Average per Day (Gallons).	Minimum Day (Gallons).	Maximum Day (Gallons).	Average Lift (Feet).	Average Duty (ft.-lbs. per 100 lbs. Coal).
1908.						
January,	1,088,800,000	35,100,000	28,100,000	46,200,000	8.34	55,200,000
February,	1,154,400,000	39,800,000	32,100,000	53,400,000	8.52	62,400,000
March,	1,093,600,000	35,300,000	30,700,000	49,100,000	8.35	60,500,000
April,	915,000,000 ¹	30,500,000 ¹	19,800,000 ¹	38,300,000 ¹	8.16 ¹	62,000,000 ¹
May,	982,300,000	31,700,000	22,300,000	49,600,000	7.86	50,400,000
June,	945,300,000	31,500,000	28,300,000	37,700,000	8.14	57,400,000
July,	1,021,700,000	33,000,000	27,200,000	43,900,000	8.20	57,700,000
August,	1,012,000,000	32,600,000	26,500,000	46,900,000	8.18	51,900,000
September,	853,600,000	28,500,000	24,100,000	40,700,000	7.98	46,900,000
October,	831,100,000	26,800,000	19,600,000	51,000,000	8.11	40,900,000
November,	713,600,000	23,800,000	19,100,000	31,200,000	7.92	39,800,000
December,	848,900,000	27,400,000	21,600,000	41,000,000	8.01	41,600,000
Total,	11,460,300,000	—	—	—	—	—
Average,	—	31,300,000	25,000,000	44,100,000	8.15	52,200,000

¹ Approximate only. On account of the Chelsea fire the pumping service at this station was abandoned from April 12 to 17. The quantities, lift and duty for the month of April have been estimated.

Alewife Brook Pumping Station.

The plant at this station consists of the original installation of small commercial pumps and engines, *i.e.*, two 9-inch Andrews vertical centrifugal pumps, with direct-connected compound marine engines, together with the recent additions. The latter consists of a specially designed engine of the vertical cross-compound type, having between the cylinders a centrifugal pump rotating on a horizontal axis.

- Contract capacity of the two original pumps: 4,500,000 gallons each, with 13-foot lift.
- Contract capacity of new pump: 13,000,000 gallons, with 13-foot lift.
- Average duty for the year: 17,100,000 foot-pounds.
- Average quantity raised each day: 3,627,000 gallons.
- Force employed: 3 engineers, 1 relief engineer, 2 screenmen, and 1 relief screenman.
- Coal used: first-quality Cumberland, costing from \$3.75 to \$4.90 per gross ton.

Table of Approximate Quantities, Lifts and Duties at the Alewife Brook Pumping Station of the North Metropolitan System.

MONTHS.	Total Pumpage (Gallons).	Average per Day (Gallons).	Minimum Day (Gallons).	Maximum Day (Gallons).	Average Lift (Feet).	Average Duty (ft.-lbs. per 100 lbs. Coal).
1908.						
January,	189,592,000	6,116,000	4,983,000	7,757,000	12.84	24,400,000
February,	177,310,000	6,118,000	4,922,000	8,406,000	12.64	24,600,000
March,	197,848,000	6,382,000	5,494,000	8,347,000	12.76	27,700,000
April,	116,195,000	3,873,000	2,414,000	6,141,000	12.53	18,800,000
May,	127,628,000	4,117,000	3,229,000	7,580,000	12.48	19,200,000
June,	93,649,000	3,122,000	2,550,000	3,814,000	12.92	15,900,000
July,	80,089,000	2,584,000	2,078,000	4,493,000	13.16	13,500,000
August,	79,038,000	2,550,000	1,994,000	4,260,000	13.10	13,400,000
September,	62,581,000	2,086,000	1,826,000	3,330,000	13.03	11,300,000
October,	69,273,000	2,235,000	1,826,000	4,799,000	12.97	11,900,000
November,	57,286,000	1,910,000	1,700,000	2,739,000	13.04	10,500,000
December,	75,231,000	2,427,000	1,544,000	4,260,000	13.02	13,700,000
Total,	1,325,720,000	-	-	-	-	-
Average,	-	3,627,000	2,880,000	5,494,000	12.87	17,100,000

SOUTH METROPOLITAN SYSTEM.

Ward Street Pumping Station.

At this station are two vertical, triple-expansion pumping engines, of the Allis-Chalmers type, operating reciprocating pumps, the plungers of which are 48 inches in diameter with a 60-inch stroke.

Contract capacity of pumps: 50,000,000 gallons each, with 45-foot lift.

Average duty for the year: 79,600,000 foot-pounds.

Average quantity raised each day: 22,300,000 gallons.

Force employed: 4 engineers, 4 firemen, 4 oilers, 4 assistant engineers, 1 machinist and 1 laborer.

Coal used: first quality Cumberland, costing from \$4.41 to \$5.00 per gross ton.

Table of Approximate Quantities, Lifts and Duties at the Ward Street Pumping Station of the South Metropolitan System.

MONTHS.	Total Pumpage (Gallons).	Average per Day (Gallons).	Minimum Day (Gallons).	Maximum Day (Gallons).	Average Lift (Feet).	Average Duty (ft.-lbs. per 100 lbs. Coal).
1908.						
January,	1,011,500,000	32,700,000	24,600,000	43,600,000	41.83	93,000,000
February,	812,000,000	28,000,000	22,300,000	41,000,000	41.93	84,000,000
March,	935,300,000	30,200,000	26,700,000	42,400,000	41.54	88,600,000
April,	786,400,000	26,200,000	18,700,000	30,300,000	41.48	81,700,000
May,	774,700,000	25,000,000	21,500,000	29,200,000	41.27	83,000,000
June,	633,500,000	21,100,000	18,000,000	25,600,000	40.62	82,000,000
July,	405,600,000	18,400,000	15,700,000	32,600,000	40.11	77,400,000
August,	576,900,000	18,600,000	15,600,000	28,900,000	40.06	75,600,000
September,	510,000,000	17,000,000	14,900,000	22,100,000	39.86	67,800,000
October,	519,400,000	16,800,000	13,100,000	29,100,000	40.06	73,100,000
November,	484,600,000	16,200,000	14,600,000	21,300,000	39.91	74,600,000
December,	532,400,000	17,200,000	15,000,000	27,000,000	40.08	74,400,000
Total,	7,982,300,000	-	-	-	-	-
Average,	-	22,300,000	18,400,000	31,100,000	40.73	79,600,000

Records from plunger displacement.
Average slip for the year about 17.6 per cent.

Quincy Pumping Station.

At this station are two compound condensing Deane pumping engines and one Lawrence centrifugal pump driven by a Sturtevant compound condensing engine.

Contract capacity of pumps: 3,000,000 Deane; 5,000,000 Deane; 10,000,000 Lawrence centrifugal.

Average duty for the year: 33,500,000 foot-pounds.

Average quantity raised each day: 3,687,000 gallons.

Force employed: 3 engineers, 1 relief engineer, 2 screenmen and 1 relief screenman.

Coal used: first-quality Cumberland, costing from \$4.415 to \$5.25 per gross ton.

Table of Approximate Quantities, Lifts and Duties at the Quincy Pumping Station of the South Metropolitan System.

MONTHS.	Total Pumpage (Gallons).	Average per Day (Gallons).	Minimum Day (Gallons).	Maximum Day (Gallons).	Average Lift (Feet).	Average Duty (ft.-lbs. per 100 lbs. Coal).
1908.						
January,	139,923,000	4,514,000	3,860,000	5,361,000	21.06	28,600,000
February,	123,327,000	4,253,000	3,780,000	4,700,000	21.04	31,100,000
March,	131,193,000	4,232,000	3,950,000	4,510,000	21.05	32,800,000
April,	121,498,000	4,050,000	3,710,000	4,500,000	21.05	37,000,000
May,	115,384,000	3,722,000	3,460,000	4,220,000	21.05	36,100,000
June,	98,380,000	3,279,000	2,800,000	3,645,000	21.05	34,400,000
July,	97,060,000	3,131,000	2,660,000	3,620,000	21.04	34,100,000
August,	103,996,000	3,355,000	2,980,000	3,765,000	20.99	33,200,000
September,	97,388,000	3,246,000	2,770,000	3,700,000	20.99	34,500,000
October,	105,763,000	3,412,000	2,910,000	4,090,000	21.05	33,200,000
November,	104,830,000	3,494,000	3,210,000	3,840,000	21.03	33,600,000
December,	110,369,000	3,560,000	3,200,000	3,885,000	21.06	32,900,000
Total,	1,349,111,000	-	-	-	-	-
Average,	-	3,687,000	3,274,000	4,153,000	21.04	33,500,000

Nut Island Screen House.

The plant at this house includes two sets of screens in duplicate, actuated by small reversing engines of the Fitchburg type. Two vertical Deane boilers, 80 horse-power each, operate the engines, provide heat for the house and burn materials intercepted at the screens.

Average quantity of sewage passing screens daily, 37,800,000 gallons.

Total materials intercepted at screens during the past year, 941.2 cubic yards.

Materials intercepted per million gallons of sewage discharge, 1.84 cubic feet.

Force employed: 3 engineers, 1 relief engineer, 3 screenmen and 1 relief screenman.

Coal used: 353.9 tons first-quality Cumberland, costing from \$4.215 to \$4.98 per gross ton.

COST OF PUMPING.

In the following tables the total cost of pumping and the rate per million foot-gallons at each of six pumping stations are shown in detail:—

Average Cost per Million Foot-gallons for Pumping at the Deer Island Station.

Volume (21,859.7 Million Gallons) × Lift (10.50 Feet) = 229,527 Million Foot-gallons.

ITEMS.	Cost.	Cost per Million Foot-gallons.
Labor,	\$11,232 61	\$0.04894
Coal,	10,154 77	.04424
Oil,	177 41	.00077
Waste,	81 55	.00036
Water,	1,190 40	.00519
Packing,	133 21	.00058
Miscellaneous supplies and renewals,	1,480 84	.00645
Totals,	\$24,450 79	\$0.10653
Labor at screens,	-	.01359

Average Cost per Million Foot-gallons for Pumping at the East Boston Station.

Volume (21,127.7 Million Gallons) × Lift (15.83 Feet) = 334,451 Million Foot-gallons.

ITEMS.	Cost.	Cost per Million Foot-gallons.
Labor,	\$14,715 23	\$0.04400
Coal,	11,618 82	.03474
Oil,	377 28	.00113
Waste,	143 79	.00043
Water,	2,226 00	.00666
Packing,	497 40	.00149
Miscellaneous supplies and renewals,	1,915 92	.00573
Totals,	\$31,494 44	\$0.09418
Labor at screens,	-	.00933

*Average Cost per Million Foot-gallons for Pumping at the Charlestown Station.*Volume (11,460.3 Million Gallons) \times Lift 8.15 Feet) = 93,401 Million Foot-gallons.

ITEMS.	Cost.	Cost per Million Foot-gallons.
Labor,	\$11,340 77	\$0.12142
Coal,	4,006 65	.04289
Oil,	171 33	.00183
Waste,	102 06	.00109
Water,	494 40	.00529
Packing,	61 79	.00066
Miscellaneous supplies and renewals,	621 43	.00665
Totals,	\$16,798 43	\$0.17983
Labor at screens,	-	.03062

*Average Cost per Million Foot-gallons for Pumping at the Alewife Brook Station.*Volume (1,325.72 Million Gallons) \times Lift (12.87 Feet) = 17,062 Million Foot-gallons.

ITEMS.	Cost.	Cost per Million Foot-gallons.
Labor,	\$5,491 96	\$0.32188
Coal,	1,845 22	.10814
Oil,	115 10	.00674
Waste,	47 88	.00281
Water,	181 56	.01064
Packing,	68 68	.00403
Miscellaneous supplies and renewals,	205 14	.01202
Totals,	\$7,955 54	\$0.46626
Labor at screens, oiling and miscellaneous services,	-	.10667

*Average Cost per Million Foot-gallons for Pumping at the Ward Street Station.*Volume (7,982.3 Million Gallons) \times Lift (40.73 Feet) = 325,119 Million Foot-gallons.

ITEMS.	Cost.	Cost per Million Foot-gallons.
Labor,	\$14,536 16	\$0.04471
Coal,	8,662 22	.02664
Oil,	256 17	.00079
Waste,	51 58	.00016
Water,	1,357 20	.00417
Packing,	335 77	.00103
Miscellaneous supplies and renewals,	1,879 00	.00578
Totals,	\$27,078 10	\$0.08328
Labor at screens,	-	.01344

Average Cost per Million Foot-gallons for Pumping at the Quincy Station.

Volume (1,349.1 Million Gallons) × Lift (21.04 Feet) = 28,385 Million Foot-gallons.

ITEMS.	Cost.	Cost per Million Foot-gallons.
Labor,	\$4,783 08	\$0.16852
Coal,	1,575 02	.05549
Oil,	31 69	.00112
Waste,	11 03	.00039
Water,	199 38	.00702
Packing,	85 11	.00300
Miscellaneous supplies and renewals,	188 13	.00663
Totals,	\$6,873 44	\$0.24217
Labor at screens, oiling and miscellaneous services,	-	.05496

Coal for use at the several stations has been purchased as follows : —

	GROSS TONS, BITUMINOUS COAL.							Contract Price per Gross Ton.
	Deer Island Pumping Station.	East Boston Pumping Station.	Charles- town Pumping Station.	Alewife Brook Pumping Station.	Ward Street Pumping Station.	Quincy Pumping Station.	Nut Island Screen House.	
Davis Coal and Coke Company.	-	1,111.110	-	-	-	-	-	\$3.69
Davis Coal and Coke Company.	-	-	484.220	-	-	-	-	3.95
Metropolitan Coal Com- pany.	-	-	66.517	-	-	-	-	4.10
Davis Coal and Coke Company.	870.00	-	-	-	-	-	-	4.15
Davis Coal and Coke Company.	-	-	-	-	-	-	233	4.20
Davis Coal and Coke Company.	-	-	-	-	802.110	-	-	4.41
Davis Coal and Coke Company.	-	-	-	-	-	124.50	-	4.45
Locke Coal Company, .	-	-	-	149.759	-	-	-	4.50
Metropolitan Coal Com- pany.	138.75	-	-	-	-	-	-	4.60
Metropolitan Coal Com- pany.	-	167.205	-	-	-	-	-	4.75
Locke Coal Company, .	-	-	-	313.499	-	-	-	4.90
George E. Frost & Co.,	-	-	-	-	-	76.584	-	4.95
Metropolitan Coal Com- pany.	1,449.00	1,516.301	231.428	-	-	-	200	4.98
Metropolitan Coal Com- pany.	-	-	-	-	1,084.239	-	-	5.00
George E. Frost & Co.,	-	-	-	-	-	206.870	-	5.25
Total gross tons, .	2,457.75	2,794.616	782.165	463.258	1,886.349	407.954	433	-
Average price per gross ton.	\$4.66	\$4.45	\$4.27	\$4.77	\$4.75	\$4.95	\$4.56	-

CHANGE OF PIPES AT ALEWIFE BROOK PUMPING STATION.

This station is located on the easterly bank of Alewife Brook in Somerville. The overflow from the suction sewer entering the station leads to this brook. Condensing water for use in the engine room is taken from the brook and the discharge from condensers is led back to the brook.

The Metropolitan Park Commission have, during the year, modified the location of this brook passing this station. The overflow from the sewer and condensing pipes has been extended to the modified lines of this brook. This has involved placing 250 feet of 24-inch cast-iron pipe and 280 feet of 8-inch cast-iron pipe. This work has been carried out by day labor under direction of the Engineer.

SOUTH METROPOLITAN OUTFALLS.

The 60-inch outlet pipes in the harbor have been in operation four years at the date of this report. These pipes are in normal condition and free from deposit. During the past year the average flow through them has been 37,800,000 gallons of sewage per day, with a maximum rate of 107,000,000 gallons in the month of January, 1908.

MATERIAL INTERCEPTED AT THE SCREENS.

The material intercepted at the screens at the North Metropolitan sewerage stations, consisting of rags, paper and other floating matters, has during the year amounted to 2,301.3 cubic yards. This is equivalent to 2.8 cubic feet for each million gallons of sewage pumped at Deer Island.

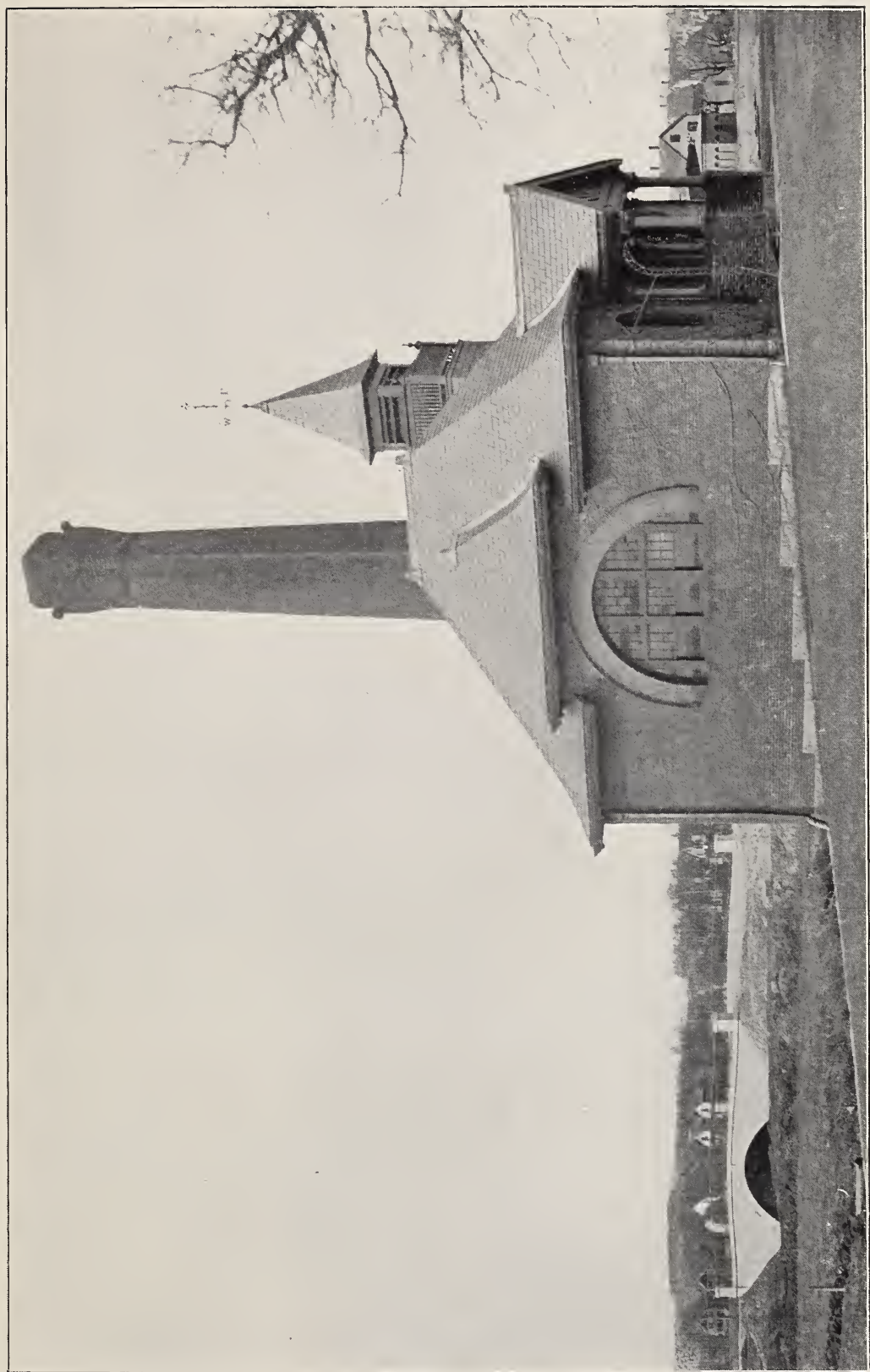
The material intercepted at the screens at the South Metropolitan sewerage stations has amounted to 2,222.7 cubic yards, equal to 4.3 cubic feet per million gallons of sewage delivered at the outfall works at Nut Island.

Studies of sewage flows in the Metropolitan sewers, siphons and outfall pipes indicate that they are free from deposit.

Respectfully submitted,

WM. M. BROWN,

Chief Engineer of Sewerage Works.



ALEWIFE BROOK SEWERAGE PUMPING STATION -- CHANGE IN LOCATION OF BROOK CHANNEL.



APPENDIX.

APPENDIX No. 1.

CONTRACTS MADE AND PENDING DURING

[NOTE. — The details of contracts made before

1. Num- ber of Con- tract.	2. WORK.	3. Num- ber of Bids.	AMOUNT OF BID.		6. Contractor.	
			4. Next to Low- est.	5. Lowest.		
1	288 ¹	Pumping engine for the Arlington station.	7	\$7,900 00	\$7,830 00	Allis-Chalmers Co., Milwaukee, Wis.
2	298 ¹	Pumping engine for the Arlington station.	2	12,700 00	5,240 00 ²	The Blake & Knowles Steam Pump Works, Boston.
3	299	4,160 tons cast iron water pipes; 4,100 tons 48-inch, 60 tons 36-inch, 130 tons special castings.	3	103,831 00	99,164 00 ²	Warren Foundry and Machine Co., Phil- lipsburg, N. J.
4	301	18 water valves; 10 36-inch, 8 12-inch.	3	7,240 00	7,124 00 ²	Coffin Valve Com- pany, Boston.
5	304	Laying water pipes in Boston and Brookline, Section 31 of the distri- bution system.	11	36,157 50 ²	32,791 00	Bruno & Petitti, Bos- ton.
6	10-M. ¹	Placing riprap at North Dike, Clinton, Mass.	2	19,250 00	14,000 00 ²	Hugh Nawn Contract ing Co., Boston.
7	11-M.	6,000 tons Vulcan coal for Chestnut Hill pumping station.	10	\$3.85 per ton.	\$3.75 ² and \$3.85 per ton.	Spring Coal Co., Bos- ton.
8	12-M.	1,300 tons Davis coal; 900 tons for Spot Pond pumping station, 400 tons for Arlington pumping station.	8	\$4.50 and \$4.10 per ton.	\$4.19 ² and \$3.95 per ton.	Davis Coal and Coke Co., Boston.
9	13-M. ¹	Steel standards for flash- boards for waste-weir of Wachusett Dam.	6	\$972 00	\$870 03 ²	New England Struc- tural Co., Boston.

¹ Contract completed.² Contract based upon this bid.

APPENDIX No. 1.

THE YEAR 1908 — WATER WORKS.
1908 have been given in previous reports.]

7. Date of Contract.	8. Date of Completion of Work.	9. Prices of Principal Items of Contracts made in 1908.	10. Value of Work done Decem- ber 31, 1908.	
Oct. 28, '05,	-	Duty trials completed Jan. 7, 1909, . . .	\$8,375 37	1
April 3, '07,	Oct. 30, '08,	- -	5,240 00	2
Aug. 1, '08,	-	Cast-iron pipe \$22.40, special castings \$46 per ton of 2,000 lbs. delivered at Brookline, Mass.	56,000 00	3
Aug. 26, '08,	-	36-inch valves, \$650; 12-inch valves, \$78, . . .	1,612 00	4
Sept. 5, '08,	-	For laying cast-iron pipe: 48-inch, \$2.60 per lin. ft.; 36-inch, \$2 per lin. ft.; 12-inch for blow-offs, \$1 per lin. ft.; for rock excavation above regular grade, \$3.25 per cu. yd.; for rock excavation below regular grade, \$4 per cu. yd.; for earth excavation below regular grade, \$1.50 per cu. yd.; for setting air valves, \$2.50 each; for chambers for 36-inch valves, \$50 each; for chambers for blow-offs, by passes or air valves, \$35 each; for concrete masonry, \$7 per cu. yd.	10,870 23	5
Sept. 6, '07,	Jan. 17, '08,	- -	14,083 00	6
July 1, '08,	-	\$3.75 to Oct. 1, \$3.85 Oct. 1 to June 1 per ton of 2,240 lbs. delivered on cars at Chestnut Hill pumping station.	12,573 83	7
July 13, '08,	-	\$4.19 per ton of 2,240 lbs. delivered in bins at the Spot Pond pumping station; \$3.95 per ton of 2,240 lbs. delivered on cars at the Arlington pumping station.	3,746 78	8
Aug. 15, '06,	Nov. 6, '08,	\$96.67 each,	893 53	9
			\$113,394 74	

CONTRACTS MADE AND PENDING DURING THE YEAR 1908 — WATER WORKS —
Concluded.

Summary of Contracts.¹

	Value of Work done Decem- ber 31, 1908.
Distribution Department, 5 contracts,	\$82,097 60
291 contracts completed from 1896 to 1907, inclusive,	15,825,335 85
	\$15,907,433 45
Deduct for work done on 11 Sudbury Reservoir contracts by the City of Boston, .	512,000 00
Total of 307 contracts,	\$15,395,433 45

¹ In this summary, contracts charged to maintenance are excluded.

APPENDIX No. 2.

TABLE No. 1. — Monthly Rainfall in Inches at Various Places on the Metropolitan Water Works, in 1908.

PLACE.	January.	February.	March.	April.	May.	June.	July.	August.	September.	October.	November.	December.	Totals.
Wachusett Watershed.													
Princeton,	3.11	4.66	2.27	2.56	5.25	1.28	3.52	6.77	0.84	2.01	0.89	2.79	35.95
Jefferson,	3.80	5.13	3.10	3.14	5.52	1.41	4.10	6.49	1.21	2.15	1.27	3.17	40.49
Sterling,	3.20	4.88	2.59	2.52	5.10	1.39	3.78	5.78	0.91	1.96	0.97	3.15	36.23
Boylston,	3.48	4.62	3.12	2.27	5.48	1.08	4.01	6.93	1.20	2.37	1.07	3.02	38.65
Sudbury Dam,	3.52	4.13	3.50	1.82	5.11	0.79	3.73	4.24	0.92	2.52	1.00	3.03	34.31
Framingham,	3.24	4.22	3.67	1.75	5.41	0.74	3.43	4.36	0.96	2.52	0.89	2.95	34.14
Ashland Dam,	3.43	4.60	3.84	1.81	5.94	0.90	3.48	4.30	0.89	2.53	0.90	3.07	35.69
Cordaville,	4.21	5.28	4.26	2.14	5.56	1.02	4.18	5.39	1.12	2.63	1.12	3.53	40.44
Lake Cochituate,	3.33	4.30	3.62	1.80	4.58	0.82	3.91	3.98	0.77	2.37	0.85	2.70	33.03
Chestnut Hill Reservoir,	4.50	6.22	4.18	2.64	4.56	1.28	4.18	5.56	1.22	4.34	1.17	3.46	43.31
Spot Pond,	3.48	4.27	3.26	2.41	3.81	0.78	3.40	3.97	0.62	3.66	1.04	2.65	33.35
Average of all,	3.57	4.76	3.40	2.26	5.12	1.04	3.79	5.25	0.97	2.64	1.02	3.05	36.87
Average, Wachusett watershed,	3.40	4.82	2.77	2.62	5.34	1.29	3.85	6.49	1.04	2.13	1.05	3.03	37.83
Average, Sudbury watershed,	3.60	4.56	3.82	1.88	5.51	0.86	3.71	4.57	0.97	2.55	0.98	3.14	36.15

TABLE NO. 2. — *Rainfall in Inches at Jefferson, Mass., in 1908.*

DAY OF MONTH.	January.	February.	March.	April.	May.	June.	July.	August.	September.	October.	November.	December.
1,	-	0.88 ³	²	-	-	-	-	-	-	-	-	-
2,	-	-	0.92 ³	0.19 ³	0.34	-	-	-	-	0.13	-	-
3,	-	-	-	-	-	-	-	-	-	-	-	-
4,	0.15 ³	-	-	-	-	-	0.84	-	-	-	-	0.17 ³
5,	-	-	-	0.34	-	-	-	0.86	-	-	-	-
6,	-	0.49 ³	0.32 ³	-	-	-	-	1.18	0.11	-	-	-
7,	²	-	-	-	²	-	-	0.28	-	-	-	1.58 ³
8,	1.21	-	0.07	²	1.54	-	-	-	-	-	0.19	-
9,	-	-	-	0.55	0.18	-	-	-	-	-	-	-
10,	-	-	-	-	-	-	-	-	-	-	-	-
11,	-	-	-	0.12	-	-	-	0.32	-	0.35	0.15	²
12,	²	-	-	-	0.08	-	0.20	-	-	-	-	0.48 ³
13,	1.29	0.10	-	0.07	-	-	-	1.69	-	-	-	-
14,	-	²	-	-	0.34	-	0.42	-	-	-	²	-
15,	-	1.14	0.20	0.47	-	²	-	-	-	-	0.62 ³	0.21 ³
16,	-	-	-	-	-	0.68	-	-	-	-	-	-
17,	-	-	²	-	-	-	0.18	0.68	-	-	-	-
18,	-	-	²	0.38	-	-	0.33	-	-	-	-	0.23 ¹
19,	-	1.24 ³	0.84 ³	-	-	-	0.39	-	-	-	0.19 ¹	-
20,	-	-	-	-	-	-	-	-	-	-	-	-
21,	-	-	-	-	²	-	-	-	-	-	-	-
22,	-	-	-	-	²	-	0.29	0.44	-	-	-	-
23,	²	0.05 ¹	0.24	-	0.43	-	-	-	-	-	-	-
24,	0.50 ¹	-	-	-	-	0.73	-	-	-	-	-	-
25,	-	-	-	0.08	-	-	1.45	-	-	²	²	-
26,	-	1.23 ³	-	-	0.07	-	-	1.04	-	0.45	0.12	-
27,	0.51	-	-	-	-	-	-	-	-	²	-	-
28,	-	-	0.09	0.10	-	-	-	-	²	0.46	-	-
29,	0.14 ¹	-	0.42	-	-	-	-	-	1.10	²	-	-
30,	-	-	-	0.84	2.54	-	-	-	-	0.76	-	²
31,	-	-	-	-	-	-	-	-	-	-	-	0.50
Total,	3.80	5.13	3.10	3.14	5.52	1.41	4.10	6.49	1.21	2.15	1.27	3.17

Total for the year 40.49 inches.

¹ Snow.² Rainfall included in that of following day.³ Rain and snow.

TABLE NO. 3.—*Rainfall in Inches at Framingham, Mass., in 1908.*

DAY OF MONTH.	January.	February.	March.	April.	May.	June.	July.	August.	September.	October.	November.	December.
1,	-	0.82 ³	0.39	²	-	-	-	-	-	²	-	-
2,	-	-	0.40 ³	0.15 ³	0.04	-	-	-	-	0.24	-	-
3,	-	-	-	-	-	-	-	-	-	-	-	-
4,	0.06	-	-	-	-	-	0.17	0.39	-	-	-	²
5,	-	²	-	0.14	-	-	-	0.64	-	-	-	0.08
6,	-	0.24 ³	²	-	-	-	-	0.62	0.18	-	-	²
7,	1.26	-	0.42 ¹	-	²	-	-	0.46	-	-	-	1.62 ³
8,	-	-	²	0.47	1.77	-	-	-	-	-	0.02	-
9,	-	-	0.09	-	0.01	-	-	-	-	-	-	-
10,	-	-	-	0.02	-	-	-	-	-	²	²	-
11,	-	-	-	0.05	-	-	-	0.07	-	0.24	0.15	²
12,	²	-	-	-	0.04	-	-	-	-	-	-	0.57 ³
13,	0.96	0.14	0.08	0.02	²	-	-	0.11	-	-	-	-
14,	-	²	-	-	0.40	-	0.16	-	-	-	²	-
15,	-	0.71	0.24	0.31	-	²	-	-	-	-	0.45	0.04
16,	0.03	-	0.02	-	0.01	0.45	-	-	-	-	-	-
17,	-	-	0.13 ¹	-	-	-	0.11	0.48	-	-	-	-
18,	-	-	²	²	-	-	0.53	-	-	-	0.06 ³	0.24 ³
19,	-	1.38 ³	0.87 ³	0.23	-	-	0.03	-	-	-	²	-
20,	-	-	-	0.02 ³	-	-	-	-	-	-	0.02	-
21,	-	-	-	-	0.08	-	²	-	-	-	-	-
22,	-	-	-	-	1.18	-	0.75	0.22	-	-	-	-
23,	²	0.14 ¹	0.18	-	-	0.08	-	-	-	-	-	-
24,	0.35 ¹	-	-	-	-	0.19	0.28	-	-	-	²	-
25,	-	0.22 ³	-	0.02	-	-	1.40	²	-	²	²	-
26,	²	²	-	-	0.01	-	-	1.37	-	0.70	0.15	-
27,	0.45 ³	0.57	²	0.02	-	-	-	-	-	-	-	-
28,	²	-	0.02	-	0.02	-	-	-	²	²	-	-
29,	0.10 ¹	-	0.82	-	-	0.02	-	-	0.78	²	0.02	-
30,	-	-	-	0.30	1.72	-	-	-	-	1.34	0.02	0.40
31,	0.03 ¹	-	0.01	-	0.13	-	-	-	-	-	-	-
Total, . . .	3.24	4.22	3.67	1.75	5.41	0.74	3.43	4.36	0.96	2.52	0.89	2.95

Total for the year 34.14 inches.

¹ Snow. ² Rainfall included in that of the following day. ³ Rain and snow.

TABLE No. 4. — *Rainfall in Inches at Chestnut Hill Reservoir in 1908.*

DATE.	Amount.	Duration.	DATE.	Amount.	Duration.
Jan. 7, . . .	1.85	2.55 P.M. to 4.40 A.M.	May 7, . . .	2.36	2.30 P.M. to 6.15 A.M.
Jan. 8, . . .	1.18	7.45 A.M. to 5.25 A.M.	May 8, . . .	.07	3.45 P.M. to 7.00 P.M.
Jan. 12, . . .	.02	9.30 A.M. to 12.15 P.M.	May 13, . . .	.30	11.50 P.M. to 4.00 P.M.
Jan. 13, . . .	.61 ¹	7.30 P.M. to 2.00 P.M.	May 14, . . .	.10	3.00 P.M. to 4.35 A.M.
Jan. 16, . . .	.09 ¹	6.15 P.M. to 11.00 P.M.	May 21, . . .	.09	12.30 P.M. to 4.45 A.M.
Jan. 23, . . .	.54	10.15 P.M. to 6.25 A.M.	May 22, . . .	.02	11.45 P.M. to 1.10 A.M.
Jan. 24, . . .	.21 ²	12.15 A.M. to 4.45 P.M.	May 23, . . .	1.30	11.35 A.M. to 12.15 A.M.
Jan. 25, . . .			May 26, . . .	.32	7.30 P.M. to 11.15 P.M.
Jan. 26, . . .			May 27, . . .		
Jan. 27, . . .			May 30, . . .		
Jan. 29, . . .			May 31, . . .		
Total, . . .	4.50		Total, . . .	4.56	
Feb. 1, . . .	1.54 ²	5.45 A.M. to 4.45 P.M.	June 16, . . .	.78	4.20 A.M. to 11.00 A.M.
Feb. 5, . . .	.54 ¹	10.00 P.M. to 9.45 P.M.	June 24, . . .	.04	3.45 A.M. to 6.30 A.M.
Feb. 6, . . .	.27	6.30 A.M. to 8.00 P.M.	June 24, . . .	.25	5.30 P.M. to 10.30 P.M.
Feb. 13, . . .	.18	10.00 P.M. to 4.55 A.M.	June 28, . . .	.16	8.45 P.M. to 6.25 A.M.
Feb. 14, . . .	.72	12.30 P.M. to 6.45 P.M.	June 30, . . .	.05	2.00 P.M. to 2.17 P.M.
Feb. 15, . . .	1.93 ²	8.00 A.M. to 1.20 A.M.	Total, . . .	1.28	
Feb. 19, . . .	.11 ¹	8.00 P.M. to 3.10 A.M.			
Feb. 20, . . .	.93	3.15 P.M. to 3.00 P.M.			
Feb. 23, . . .					
Feb. 24, . . .					
Feb. 26, . . .					
Feb. 27, . . .					
Total, . . .	6.22				
Mar. 1, . . .	.96 ²	5.15 P.M. to 1.55 A.M.	July 4, . . .	.51	1.05 P.M. to 1.45 P.M.
Mar. 3, . . .	.55 ²	2.00 P.M. to 1.25 A.M.	July 14, . . .	.14	5.00 P.M. to 7.00 P.M.
Mar. 6, . . .	.15	6.30 P.M. to 7.30 A.M.	July 15, . . .	.05	6.30 P.M. to 7.00 P.M.
Mar. 7, . . .	.21	10.15 P.M. to 2.40 A.M.	July 18, . . .	.11	2.30 P.M. to 3.00 P.M.
Mar. 8, . . .	.25	3.50 P.M. to 8.00 P.M.	July 18, . . .	.33	11.10 P.M. to 5.55 A.M.
Mar. 9, . . .	.20 ²	1.30 P.M. to 6.00 P.M.	July 19, . . .	.19	12.30 A.M. to 5.55 A.M.
Mar. 13, . . .	.88 ²	1.00 P.M. to 3.30 P.M.	July 20, . . .	.84	12.20 A.M. to 7.00 A.M.
Mar. 14, . . .	.20	1.30 P.M. to 1.15 A.M.	July 22, . . .	.03	1.10 A.M. to 6.35 A.M.
Mar. 15, . . .	.78	9.45 A.M. to 8.00 P.M.	July 23, . . .	.04	9.45 A.M. to 1.30 P.M.
Mar. 17, . . .			July 24, . . .	1.94	6.30 A.M. to 1.30 A.M.
Mar. 18, . . .			July 25, . . .		
Mar. 19, . . .			July 26, . . .		
Mar. 23, . . .			Total, . . .	4.18	
Mar. 24, . . .					
Mar. 29, . . .					
Total, . . .	4.18				
Apr. 2, . . .	.19 ²	2.30 A.M. to 11.30 A.M.	Aug. 4, . . .	.29	5.40 A.M. to 8.00 A.M.
Apr. 3, . . .	.14	9.30 P.M. to 3.55 A.M.	Aug. 5, . . .	.38	2.05 A.M. to 8.45 A.M.
Apr. 5, . . .	.51	1.00 P.M. to 2.15 A.M.	Aug. 6, . . .	.20	12.30 A.M. to 1.00 A.M.
Apr. 6, . . .	.06	5.00 P.M. to 10.00 P.M.	Aug. 6, . . .	.25	3.30 P.M. to 9.30 P.M.
Apr. 14, . . .	.03	8.55 A.M. to 11.55 A.M.	Aug. 7, . . .	1.84	1.35 P.M. to 4.30 P.M.
Apr. 15, . . .	.31	1.00 P.M. to 11.30 P.M.	Aug. 10, . . .	.03	8.00 P.M. to 8.40 P.M.
Apr. 18, . . .	.40	4.30 P.M. to 5.35 A.M.	Aug. 11, . . .	.10	5.30 P.M. to 7.55 P.M.
Apr. 19, . . .	.03	1.15 P.M. to 4.30 P.M.	Aug. 13, . . .	.03	8.30 P.M. to 3.10 A.M.
Apr. 19, . . .	.04	1.15 P.M. to 11.30 P.M.	Aug. 17, . . .	.15	6.10 A.M. to 1.30 P.M.
Apr. 20, . . .	.09	11.45 P.M. to 12.30 A.M.	Aug. 17, . . .	.21	7.50 P.M. to 10.45 P.M.
Apr. 25, . . .	.06	2.40 A.M. to 6.30 A.M.	Aug. 22, . . .	.35	6.00 A.M. to 8.35 A.M.
Apr. 26, . . .	.78	9.30 P.M. to 1.25 A.M.	Aug. 22, . . .	.03	12.30 P.M. to 1.25 P.M.
Apr. 28, . . .			Aug. 26, . . .	1.70	12.25 A.M. to 4.00 A.M.
Apr. 30, . . .			Aug. 27, . . .		
May 1, . . .			Total, . . .	5.56	
Total, . . .	2.64				
			Sept. 6, . . .	.13	6.45 A.M. to 12.30 P.M.
			Sept. 27, . . .	1.09	10.30 P.M. to 6.40 A.M.
			Sept. 28, . . .		
			Total, . . .	1.22	

¹ Snow.² Rain and snow.

TABLE No. 4. — *Rainfall in Inches at Chestnut Hill Reservoir in 1908 —*
Concluded.

DATE.	Amount.	Duration.	DATE.	Amount.	Duration.
Oct. 1, . . .	.68	8.20 P.M. to	Dec. 4, . . .	.16	3.30 P.M. to 9.30 P.M.
Oct. 2, . . .		6.20 A.M.	Dec. 6, . . .	1.50	11.45 P.M. to
Oct. 10, . . .		11.55 P.M. to	Dec. 7, . . .		5.00 P.M.
Oct. 11, . . .	.20	8.05 A.M.	Dec. 11, . . .	.73 ²	10.35 A.M. to 4.00 P.M.
Oct. 26, . . .	1.42	9.10 A.M. to 10.40 P.M.	Dec. 12, . . .	.21 ²	9.20 A.M. to 12.15 P.M.
Oct. 28, . . .	2.04	6.00 P.M. to	Dec. 15, . . .	.16	2.45 A.M. to 9.00 A.M.
Oct. 30, . . .		11.10 A.M.	Dec. 18, . . .	.17 ²	6.45 A.M. to 6.30 P.M.
Total, . . .	4.34		Dec. 30, . . .	.53	6.30 P.M. to
			Dec. 31, . . .		1.45 A.M.
			Total, . . .	3.46	
Nov. 8, . . .	.04	8.45 A.M. to 6.15 P.M.			
Nov. 10, . . .	.02	10.00 P.M. to			
Nov. 11, . . .		7.00 A.M.			
Nov. 11, . . .	.16	2.05 P.M. to			
Nov. 12, . . .		1.45 A.M.			
Nov. 14, . . .	.65	8.10 P.M. to			
Nov. 15, . . .		7.15 A.M.			
Nov. 18, . . .	.08	6.45 A.M. to 11.35 A.M.			
Nov. 19, . . .	.10	6.55 P.M. to			
Nov. 20, . . .		4.40 A.M.			
Nov. 26, . . .	.10	9.30 P.M. to 11.55 P.M.			
Nov. 30, . . .	.02	10.00 P.M. to 11.35 P.M.			
Total, . . .	1.17				

Total for the year 43.31 inches.

² Rain and snow.

TABLE NO. 5. — *Rainfall in Inches on the Wachusett Watershed,¹ 1897 to 1908.*

YEAR.	January.	February.	March.	April.	May.	June.	July.	August.	September.	October.	November.	December.	Totals.
1897,	3.46	2.86	4.01	2.32	5.06	5.11	8.65	3.47	1.93	0.94	7.62	6.41	51.84
1898,	6.65	3.30	2.27	4.43	3.38	3.11	3.01	10.61	3.15	7.21	6.81	3.99	57.92
1899,	2.93	5.12	6.75	1.94	1.33	5.51	3.82	3.20	4.11	2.72	1.94	2.03	41.40
1900,	4.56	8.69	6.19	2.76	4.34	3.59	3.20	3.18	3.46	2.90	6.44	3.15	52.46
1901,	1.75	1.13	5.82	9.64	7.02	1.51	5.66	4.58	3.10	3.70	2.43	9.36	55.70
1902,	2.72	4.91	5.27	4.36	2.24	2.51	3.87	3.95	4.26	6.36	0.93	7.20	48.58
1903,	2.85	4.42	6.53	3.10	1.24	10.37	3.43	3.88	2.93	4.43	2.36	3.99	49.58
1904,	4.02	2.66	3.40	7.45	2.99	3.44	3.84	3.68	5.30	1.78	1.62	2.88	43.06
1905,	6.10	1.72	3.95	2.60	0.83	4.88	5.39	3.09	6.90	1.81	2.52	3.79	43.58
1906,	2.59	2.74	5.17	3.12	6.58	5.95	5.52	4.34	2.61	3.95	2.25	4.26	49.08
1907,	2.84	2.32	1.82	2.65	2.96	3.54	3.03	1.26	9.50	5.68	5.74	4.40	45.74
1908,	3.40	4.82	2.77	2.62	5.34	1.29	3.85	6.49	1.04	2.13	1.05	3.03	37.83
Total,	40.47	44.69	54.00	46.99	43.31	50.81	53.27	51.73	48.29	43.61	41.71	54.49	576.77
Average (12 years),	3.37	3.72	4.50	3.92	3.61	4.23	4.44	4.31	4.02	3.63	3.48	4.54	48.06

¹ Means of observations at four places, as follows: January, 1897, to December, 1900, Princeton, Jefferson, Sterling and South Clinton; January, 1901, to December, 1908, Princeton, Jefferson, Sterling and Boylston.

TABLE No. 6. — *Rainfall in Inches on the Sudbury Watershed, 1875 to 1908.*

YEAR.	January.	February.	March.	April.	May.	June.	July.	August.	September.	October.	November.	December.	Totals.
1875,	2.42	3.15	3.74	3.23	3.56	6.24	3.57	5.53	3.43	4.85	4.83	0.94	45.49
1876,	1.83	4.21	7.43	4.20	2.76	2.04	9.13	1.72	4.62	2.24	5.76	3.62	49.56
1877,	3.22	0.74	8.36	3.43	3.70	2.43	2.95	3.68	0.32	8.52	5.80	0.87	44.02
1878,	5.63	5.97	4.69	5.79	0.96	3.88	2.97	6.94	1.29	6.42	7.02	6.37	57.93
1879,	2.48	3.56	5.14	4.72	1.58	3.79	3.93	6.51	1.88	0.81	2.68	4.34	41.42
1880,	3.57	3.98	3.31	3.11	1.84	2.14	6.27	4.01	1.60	3.74	1.78	2.83	38.18
1881,	5.56	4.65	5.73	2.00	3.51	5.39	2.35	1.36	2.62	2.95	4.09	3.96	44.17
1882,	5.95	4.55	2.65	1.82	5.07	1.66	1.77	1.67	8.74	2.07	1.15	2.30	39.40
1883,	1.84	4.19	4.19	1.84	4.19	2.40	2.68	0.73	1.62	5.60	1.81	3.55	32.78
1884,	5.09	6.54	1.78	4.41	3.47	3.44	3.67	4.65	0.85	2.48	2.65	5.17	47.14
1885,	4.71	3.87	4.02	3.60	3.48	2.87	1.43	7.18	1.43	5.09	6.09	2.72	43.54
1886,	6.36	6.28	3.61	2.22	3.00	1.47	3.27	4.10	2.90	3.24	4.64	4.97	46.06
1887,	5.20	4.78	4.90	4.27	1.16	2.65	3.76	5.28	1.32	2.83	2.67	3.88	42.70
1888,	4.15	3.68	6.02	2.43	4.82	2.54	1.41	6.22	8.59	4.99	7.22	5.40	57.47
1889,	5.37	1.65	2.37	3.41	2.95	2.80	8.94	4.18	4.60	4.25	6.29	3.14	49.95
1890,	2.53	3.51	7.73	2.64	5.21	2.03	2.46	3.87	6.00	10.51	1.20	5.31	53.00
1891,	7.02	5.23	6.48	3.91	2.01	3.77	2.36	4.73	2.38	3.83	3.09	3.68	49.52
1892,	5.85	3.14	4.06	0.83	5.58	2.76	4.23	4.44	2.84	1.17	5.80	1.13	41.83
1893,	2.92	8.20	3.67	3.60	6.61	2.38	2.57	5.41	1.74	4.07	2.20	4.86	48.23
1894,	4.09	3.91	1.43	3.42	4.24	1.15	3.26	2.03	2.63	5.34	3.43	4.81	39.74
1895,	4.06	1.39	2.98	5.25	2.02	2.77	5.04	4.15	2.30	10.68	6.63	3.35	50.62
1896,	2.39	7.18	5.24	1.57	2.57	3.22	2.51	2.40	7.72	3.76	3.02	2.12	43.70
1897,	4.00	2.91	3.66	2.82	4.37	4.46	5.44	3.51	2.94	0.47	6.40	5.21	46.19
1898,	6.83	4.49	2.40	4.66	3.22	2.48	4.09	8.17	2.62	6.71	6.93	3.28	55.88
1899,	4.18	4.91	7.01	1.90	1.45	2.51	3.22	1.43	3.95	2.69	2.18	1.78	37.21
1900,	4.96	9.14	6.35	2.58	4.32	2.99	2.42	2.26	3.36	3.83	5.70	2.74	50.65
1901,	1.82	1.52	6.57	8.60	7.23	1.38	5.71	4.57	3.30	2.82	2.90	9.69	56.11
1902,	2.52	6.18	5.34	4.13	1.86	2.89	2.94	3.40	4.54	4.44	1.45	6.38	46.07
1903,	3.80	3.95	6.63	2.99	0.93	9.25	2.77	3.67	1.75	4.72	1.56	3.14	45.16
1904,	4.87	3.00	2.72	8.87	2.65	2.80	1.96	3.86	5.80	1.64	1.73	2.92	42.82
1905,	5.26	2.20	3.15	2.72	1.31	5.00	5.47	2.70	6.88	1.54	2.07	4.01	42.31
1906,	2.47	2.92	6.32	2.88	5.66	3.91	3.42	3.02	3.30	3.40	2.69	4.49	44.48
1907,	3.28	2.17	1.91	3.41	3.63	3.53	1.86	1.07	8.76	4.17	6.12	4.47	44.38
1908,	3.60	4.56	3.82	1.88	5.51	0.86	3.71	4.57	0.97	2.55	0.98	3.14	36.15
Total,	140.80	141.99	152.99	119.14	116.43	105.88	124.57	133.02	119.49	138.42	130.56	130.57	1,553.86
Average (34 years),	4.14	4.18	4.50	3.50	3.42	3.11	3.66	3.91	3.51	4.07	3.84	3.84	45.70

¹ Means of observations at several places, as follows: January, 1875, to April, 1876, Lake Cochituate; April to June, 1876, Lake Cochituate, Westborough and Hopkinton; June to December, 1876, Lake Cochituate, Southborough, Marlborough, Westborough and Hopkinton; December, 1876, to January, 1883, Framingham, Southborough, Marlborough and Hopkinton; January, 1883, to January, 1884, Framingham and Southborough; January, 1884, to January, 1890, Framingham and Westborough; January, 1890, to May, 1898, Framingham and Ashland Dam; June, 1898, to December, 1908, Framingham, Ashland Dam, Cordaville and Sudbury Dam.

TABLE No. 7.—Yield of the Wachusett Watershed in Gallons per Day per Square Mile¹ from 1897 to 1908.

MONTH.	1897.	1898.	1899.	1900.	1901.	1902.	1903.	1904.	1905.	1906.	1907.	1908.	Mean for 12 Years, 1897-1908.
January,	796,000	1,563,000	2,092,000	796,000	519,000	1,676,000	1,265,000	659,000	1,266,000	1,132,000	1,453,000	1,738,000	1,254,000
February,	931,000	1,635,000	1,090,000	4,054,000	356,000	1,401,000	2,133,000	927,000	452,000	1,027,000	692,000	1,736,000	1,378,000
March,	2,760,000	3,088,000	2,776,000	3,722,000	2,718,000	3,992,000	3,423,000	3,008,000	3,004,000	1,800,000	1,697,000	2,192,000	2,872,000
April,	1,632,000	2,027,000	3,376,000	1,580,000	4,986,000	2,159,000	2,238,000	2,984,000	1,617,000	2,109,000	1,436,000	1,269,000	2,299,000
May,	1,163,000	1,300,000	862,000	1,382,000	2,729,000	1,031,000	569,000	1,498,000	445,000	1,533,000	965,000	1,415,000	1,256,000
June,	1,181,000	828,000	561,000	578,000	985,000	410,000	2,131,000	762,000	542,000	1,184,000	773,000	403,000	867,000
July,	1,442,000	333,000	354,000	217,000	477,000	292,000	624,000	497,000	365,000	728,000	335,000	220,000	494,000
August,	896,000	1,325,000	236,000	197,000	512,000	297,000	474,000	355,000	321,000	591,000	87,000	443,000	481,000
September,	380,000	676,000	250,000	127,000	320,000	241,000	375,000	494,000	1,228,000	277,000	810,000	88,000	442,000
October,	243,000	1,509,000	245,000	282,000	647,000	950,000	689,000	347,000	367,000	530,000	1,382,000	158,000	617,000
November,	1,283,000	2,170,000	430,000	875,000	517,000	635,000	634,000	343,000	442,000	749,000	2,540,000	125,000	901,000
December,	2,275,000	2,061,000	359,000	1,570,000	3,234,000	1,848,000	954,000	440,000	1,018,000	794,000	1,961,000	387,000	141,800
Average for year,	1,253,000	1,551,000	1,051,000	1,264,000	1,507,000	1,248,000	1,285,000	1,025,000	926,000	1,043,000	1,180,000	847,000	1,189,000
Average for driest six months,	886,000	1,013,000	312,000	377,000	576,000	471,000	626,000	413,000	541,000	613,000	725,000	238,000	632,000

¹ The area of the watershed used in making up these records included water surfaces amounting to 2.2 per cent. of the whole area from 1897 to 1902, inclusive, to 2.4 per cent. in 1903, to 3.6 per cent. in 1904, to 4.1 per cent. in 1905, to 5.1 per cent. in 1906, to 6.0 per cent. in 1907, and to 7.0 per cent. in 1908.

TABLE No. 8. — *Yield of the Sudbury Watershed in Gallons per Day per Square Mile¹ from 1875 to 1908.*

MONTH.	1875.	1876.	1877.	1878.	1879.	1880.	1881.	1882.	1883.	1884.	1885.
January,	103,000	643,000	658,000	1,810,000	700,000	1,120,000	415,000	1,241,000	335,000	995,000	1,235,000
February,	1,496,000	1,368,000	949,000	2,465,000	1,711,000	1,787,000	1,546,000	2,403,000	1,033,000	2,842,000	1,554,000
March,	1,604,000	4,435,000	4,814,000	3,507,000	2,330,000	1,374,000	4,004,000	2,839,000	1,611,000	3,785,000	1,572,000
April,	3,049,000	3,292,000	2,394,000	1,626,000	3,116,000	1,169,000	1,546,000	867,000	1,350,000	2,853,000	1,815,000
May,	1,188,000	1,138,000	1,391,000	1,394,000	1,114,000	514,000	965,000	1,292,000	937,000	1,030,000	1,336,000
June,	870,000	222,000	597,000	506,000	413,000	175,000	1,338,000	529,000	300,000	416,000	426,000
July,	321,000	183,000	202,000	128,000	157,000	176,000	276,000	86,000	115,000	224,000	62,000
August,	396,000	405,000	121,000	476,000	395,000	119,000	148,000	55,000	79,000	257,000	240,000
September,	207,000	184,000*	60,000	161,000	141,000	80,000	197,000	307,000	91,000	44,000	121,000
October,	646,000	234,000	631,000	516,000	71,000	102,000	186,000	299,000	186,000	83,000	336,000
November,	1,302,000	1,088,000	1,418,000	1,693,000	206,000	205,000	395,000	209,000	205,000	175,000	1,177,000
December,	584,000	453,000	1,290,000	3,177,000	463,000	175,000	775,000	315,000	194,000	925,000	1,174,000
Average for year,	972,000	1,135,000	1,214,000	1,452,000	894,000	578,000	979,000	862,000	533,000	1,129,000	901,000
Average for driest six months,	574,000	384,000	502,000	532,000	230,000	143,000	330,000	211,000	145,000	200,000	391,000

¹ The area of the Sudbury watershed used in making up these records included water surfaces amounting to 1.9 per cent. of the whole area from 1875 to 1878, inclusive, and was subsequently increased by the construction of storage reservoirs to 3.0 per cent. in 1879, 3.4 per cent. in 1885, 3.9 per cent. in 1894 and 6.5 per cent. in 1898. The watershed also contains extensive areas of swampy land, which, though covered with water at times, are not included in the above percentages of water surfaces.

TABLE No. 8. — *Yield of the Sudbury Watershed in Gallons per Day per Square Mile¹ from 1875 to 1908* — Continued.

MONTH.	1886.	1887.	1888.	1889.	1890.	1891.	1892.	1893.	1894.	1895.	1896.	1897.
January,	1,461,000	2,589,000	1,053,000	2,782,000	1,254,000	3,018,000	1,870,000	434,000	693,000	1,034,000	1,084,000	845,000
February,	4,801,000	2,829,000	1,950,000	1,196,000	1,529,000	3,486,000	943,000	1,512,000	991,000	541,000	2,676,000	1,067,000
March,	2,059,000	2,868,000	3,238,000	1,338,000	3,643,000	4,453,000	1,955,000	3,245,000	2,238,000	2,410,000	3,835,000	2,565,000
April,	1,947,000	2,620,000	2,645,000	1,410,000	1,875,000	2,397,000	871,000	2,125,000	1,640,000	2,515,000	1,494,000	1,515,000
May,	720,000	1,009,000	1,632,000	880,000	1,366,000	583,000	1,259,000	2,883,000	840,000	636,000	360,000	915,000
June,	203,000	413,000	421,000	653,000	568,000	413,000	428,000	440,000	419,000	174,000	399,000	962,000
July,	116,000	115,000	117,000	634,000	107,000	149,000	214,000	158,000	161,000	231,000	95,000	658,000
August,	94,000	214,000	379,000	1,432,000	132,000	163,000	280,000	181,000	209,000	229,000	57,000	591,000
September,	117,000	111,000	1,155,000	823,000	457,000	203,000	229,000	108,000	150,000	89,000	388,000	182,000
October,	146,000	190,000	1,999,000	1,230,000	2,272,000	210,000	126,000	222,000	374,000	1,379,000	592,000	94,000
November,	673,000	369,000	2,758,000	1,941,000	1,215,000	305,000	697,000	319,000	836,000	2,777,000	659,000	909,000
December,	1,020,000	643,000	3,043,000	2,241,000	996,000	544,000	485,000	796,000	716,000	1,782,000	657,000	1,584,000
Average for year,	1,087,000	1,154,000	1,697,000	1,383,000	1,285,000	1,315,000	781,000	1,037,000	770,000	1,152,000	1,019,000	991,000
Average for driest six months,	223,000	234,000	953,000	944,000	747,000	239,000	327,000	237,000	356,000	460,000	314,000	564,000

¹ The area of the Sudbury watershed used in making up these records included water surfaces amounting to 1.9 per cent. of the whole area from 1875 to 1878, inclusive, and was subsequently increased by the construction of storage reservoirs to 3.0 per cent. in 1879, 3.4 per cent. in 1885, 3.9 per cent. in 1894 and 6.5 per cent. in 1898. The watershed also contains extensive areas of swampy land, which, though covered with water at times, are not included in the above percentages of water surfaces.

TABLE No. 8. — *Yield of the Sudbury Watershed in Gallons per Day per Square Mile¹ from 1875 to 1908* — Concluded.

MONTH.	1898.	1899.	1900.	1901.	1902.	1903.	1904.	1905.	1906.	1907.	1908.	Mean for 34 Years, 1875-1908.
January,	1,638,000	2,288,000	794,000	437,000	1,763,000	1,736,000	477,000	1,410,000	1,128,000	1,351,000	1,925,000	1,245,000
February,	3,022,000	1,381,000	3,800,000	300,000	1,674,000	2,279,000	882,000	330,000	1,041,000	624,000	1,536,000	1,746,000
March,	2,604,000	4,205,000	3,654,000	2,755,000	4,199,000	3,454,000	2,999,000	2,497,000	2,409,000	1,658,000	2,257,000	2,894,000
April,	1,829,000	2,521,000	1,350,000	4,204,000	1,885,000	2,261,000	3,294,000	1,613,000	1,949,000	1,607,000	1,117,000	2,053,000
May,	1,246,000	511,000	1,312,000	2,954,000	743,000	351,000	1,745,000	297,000	1,059,000	888,000	1,046,000	1,104,000
June,	530,000	66,000	316,000	753,000	303,000	1,987,000	419,000	467,000	707,000	761,000	194,000	523,000
July,	231,000	19,000	—18,000	306,000	66,000	445,000	62,000	177,000	398,000	9,000	—14,000	187,000
August,	1,107,000	—35,000	—34,000	424,000	135,000	307,000	170,000	114,000	180,000	—104,000	102,000	265,000
September,	369,000	94,000	65,000	305,000	178,000	130,000	397,000	1,246,000	19,000	541,000	—82,000	261,000
October,	1,160,000	115,000	186,000	412,000	506,000	492,000	191,000	158,000	301,000	741,000	47,000	483,000
November,	1,986,000	304,000	663,000	474,000	444,000	363,000	289,000	279,000	483,000	1,998,000	71,000	850,000
December,	1,799,000	220,000	1,096,000	2,695,000	1,779,000	582,000	269,000	887,000	659,000	2,632,000	136,000	1,064,000
Average for year,	1,450,000	973,000	1,082,000	1,342,000	1,140,000	1,190,000	931,000	795,000	860,000	1,010,000	694,000	1,053,000
Average for driest six months,	777,000	93,000	194,000	445,000	271,000	388,000	225,000	403,000	341,000	471,000	44,000	426,000

¹ The area of the Sudbury watershed used in making up these records included water surfaces amounting to 1.9 per cent. of the whole area from 1875 to 1878, inclusive, and was subsequently increased by the construction of storage reservoirs to 3.0 per cent. in 1879, 3.4 per cent. in 1885, 3.9 per cent. in 1894 and 6.5 per cent. in 1898. The watershed also contains extensive areas of swampy land, which, though covered with water at times, are not included in the above percentages of water surfaces.

TABLE No. 9. — *Wachusett System. — Statistics of Flow of Water, Storage and Rainfall in 1908.*

[Watershed above dam = 118.19 square miles.]

MONTH.	Quantity of Water discharged through Wachusett Aqueduct (Gallons per Day). ¹	Quantity of Water wasted into River below Dam (Gallons per Day).	STORAGE. ²		Total Yield of Watershed (Gallons per Day).	Rainfall (Inches).	Rainfall collected (Inches).	Percentage of Rainfall collected.
			Gain (Gallons per Day).	Loss (Gallons per Day).				
January,	43,433,000	2,968,000	159,033,000	-	205,445,000	3.40	3.101	91.3
February,	99,134,000	2,759,000	103,228,000	-	205,121,000	4.82	2.896	60.1
March,	101,426,000	22,810,000	134,819,000	-	259,055,000	2.77	3.910	141.2
April,	120,797,000	9,250,000	19,947,000	-	149,993,000	2.62	2.191	83.5
May,	109,726,000	23,603,000	33,877,000	-	167,206,000	5.34	2.524	47.3
June,	124,440,000	9,323,000	-	86,120,000	47,643,000	1.29	0.696	53.9
July,	134,510,000	3,226,000	-	111,637,000	26,039,000	3.85	0.393	10.2
August,	121,487,000	2,568,000	-	71,706,000	52,348,000	6.49	0.790	12.2
September,	135,240,000	2,633,000	-	127,520,000	10,353,000	1.04	0.151	14.5
October,	89,261,000	3,432,000	-	73,987,000	18,706,000	2.13	0.282	13.3
November,	34,220,000	3,043,000	-	22,453,000	14,810,000	1.05	0.216	20.6
December,	175,513,000	3,048,000	-	132,781,000	45,781,000	3.03	0.691	22.8
Total,	-	-	-	-	-	37.83	17.841	-
Average for year,	107,519,000	7,428,000	-	14,826,000	100,122,000	-	-	47.2

¹ Including quantities wasted in cleaning aqueduct.

² Aggregate storage in Wachusett Reservoir and in ponds and mill reservoirs.

TABLE No. 10. — *Sudbury System. — Statistics of Flow of Water, Storage and Rainfall in 1908.*

[Watershed from 1875 to 1878 inclusive = 77,764 square miles; in 1879 and 1880 = 78,238 square miles; and from 1881 to 1908 inclusive = 75.2 square miles.]

MONTH.	Quantity of Water received through Wachuset Aqueduct (Gallons per Day). ¹	Quantity of Water discharged through Sudbury Aqueduct (Gallons per Day). ²	Quantity of Water discharged through Weston Aqueduct (Gallons per Day). ²	Quantity of Water used by Framingham Water Works (Gallons per Day).	Quantity of Water diverted from Sewers, etc. (Gallons per Day).	Quantity of Water wasted into River below Lowest Dam (Gallons per Day).	STORAGE.		Total Yield of Watershed (Gallons per Day).	Rainfall (Inches).	Rainfall collected (Inches).	Percentage of Rainfall collected.
							Gain (Gallons per Day).	Loss (Gallons per Day).				
January, . . .	43,439,000	92,687,000	30,332,000	513,000	1,935,000	78,042,000	-	15,310,000	144,761,000	3.60	3.434	95.4
February, . . .	99,134,000	101,534,000	29,734,000	597,000	1,355,000	80,083,000	1,362,000	-	115,531,000	4.56	2.544	56.3
March, . . .	101,426,000	94,071,000	29,745,000	503,000	1,623,000	121,397,000	23,819,000	-	169,732,000	3.82	4.026	105.5
April, . . .	120,797,000	95,570,000	29,917,000	497,000	1,463,000	76,530,000	893,000	-	84,013,000	1.88	1.929	102.6
May, . . .	109,726,000	98,677,000	30,110,000	523,000	1,294,000	49,961,000	7,790,000	-	78,629,000	5.51	1.865	33.9
June, . . .	124,440,000	99,123,000	30,180,000	650,000	857,000	16,197,000	-	7,947,000	14,620,000	0.86	0.335	38.9
July, . . .	134,510,000	98,345,000	29,706,000	713,000	594,000	1,500,000	2,594,000	-	- 1,058,000	3.71	-0.025	-0.7
August, . . .	121,487,000	95,087,000	29,558,000	626,000	629,000	6,555,000	-	3,332,000	7,635,000	4.57	0.181	4.0
September, . . .	135,240,000	97,147,000	29,930,000	613,000	547,000	2,233,000	-	1,380,000	- 6,150,000	0.97	-0.141	-14.5
October, . . .	89,261,000	91,110,000	29,706,000	561,000	487,000	1,500,000	-	30,590,000	3,513,000	2.55	0.083	3.3
November, . . .	34,017,000	78,303,000	30,300,000	500,000	713,000	6,387,000	-	76,857,000	5,330,000	0.98	0.122	12.5
December, . . .	175,513,000	91,135,000	30,474,000	568,000	461,000	7,194,000	55,910,000	-	10,229,000	3.14	0.243	7.7
Total, . . .	-	-	-	-	-	-	-	-	-	36.15	14.616	-
Av. for year, . .	107,502,000	94,381,000	29,975,000	572,000	996,000	37,195,000	-	3,425,000	52,190,000	-	-	40.4

¹ Not including quantities of water wasted in cleaning aqueduct, which were not discharged into Sudbury Reservoir.² Including quantities of water wasted from aqueduct.

TABLE No. 11. — *Cochituate System. — Statistics of Flow of Water, Storage and Rainfall in 1908.*

[Watershed of lake = 18.87 square miles.¹]

MONTH.	Quantity of Water received from External Sources (Gallons per Day). ²	Quantity of Water discharged through Cochituate Aqueduct (Gallons per Day). ³	Quantity of Water diverted from Water-Sewers, etc. (Gallons per Day).	Quantity of Water wasted at Outlet of Lake (Gallons per Day).	STORAGE.		Total Yield of Water-shed (Gallons per Day).	Rainfall (Inches).	Rainfall collected (Inches).	Percentage of Rainfall collected.
					Gain (Gallons per Day).	Loss (Gallons per Day).				
January,	-	4,023,000	1,184,000	21,206,000	-	1,419,000	24,993,000	3.33	2.36	71.0
February,	-	12,469,000	924,000	15,224,000	803,000	-	29,421,000	4.30	2.60	60.5
March,	-	706,000	1,129,000	33,513,000	584,000	-	35,932,000	3.62	3.40	93.8
April,	-	-	927,000	17,457,000	257,000	-	18,640,000	1.80	1.71	94.7
May,	-	-	600,000	14,129,000	1,510,000	-	16,239,000	4.58	1.53	33.5
June,	-	7,530,000	383,000	3,667,000	-	7,730,000	3,840,000	0.82	0.35	42.8
July,	-	11,129,000	126,000	-	-	8,271,000	2,984,000	3.91	0.28	7.2
August,	-	1,039,000	194,000	-	1,016,000	-	2,248,000	3.98	0.21	5.3
September,	-	707,000	133,000	-	-	1,200,000	-360,000	0.77	-0.03	-4.3
October,	-	-	158,000	-	1,161,000	-	1,319,000	2.37	0.12	5.3
November,	13,000	8,347,000	207,000	-	-	7,043,000	1,497,000	0.85	0.14	16.1
December,	-	3,645,000	158,000	-	923,000	-	4,726,000	2.70	0.45	16.5
Total,	-	-	-	-	-	-	-	33.03	13.12	-
Average for year,	1,000	4,091,000	509,000	8,769,000	-	1,610,000	11,758,000	-	-	39.7

¹ Not including the watershed of Dudley Pond.

² From Framingham reservoirs Nos. 1, 2 and 3.

³ Including quantities wasted in cleaning aqueduct.

TABLE No. 12. — *Elevations of Water Surfaces of Reservoirs above Boston City Base at the Beginning of Each Month.*

DATE.	Chestnut Hill Reservoir. Ordinary High Water =134.00.	Lake Cochituate. High Water =144.36.	Farm Pond. High Water =159.25.	Spot Pond. High Water =163.00.	Weston Reservoir. High Water =200.00.	FRAMINGHAM RESERVOIR.			Ashland Reservoir. Flash Boards 225.23.	Sudbury Reservoir. Flash Boards 259.97.	Hopkinton Reservoir. Flash Boards 305.00.	Whitehall Reservoir. Ordinary High Water =337.91.	Wachusett Reservoir. Ordinary High Water =395.00.
						No. 1. Flash Boards 169.27.	No. 2. Flash Boards 177.12.	No. 3. Flash Boards 186.50.					
Jan. 1, 1908, .	134.05	144.27	158.99	163.04	200.00	168.01	176.31	182.20	220.48	259.65	300.66	337.63	384.31
Feb. 1, 1908, .	133.52	144.10	159.20	162.73	200.00	167.88	176.18	182.96	224.51	257.50	304.27	337.23	388.45
Mar. 1, 1908, .	133.82	144.19	159.67	163.02	200.00	167.98	176.28	182.11	223.22	258.44	302.89	336.40	390.75
April 1, 1908, .	133.99	144.26	159.79	163.04	200.04	168.23	176.37	185.68	224.67	259.34	304.48	335.78	393.79
May 1, 1908, .	132.45	144.29	159.56	163.09	200.01	167.75	177.28	185.37	224.66	259.29	304.39	336.16	394.31
June 1, 1908, .	133.71	144.47	159.66	162.98	200.07	165.16	177.48	185.83	225.30	259.37	305.34	337.00	395.17
July 1, 1908, .	132.74	143.55	159.09	162.71	200.05	167.64	177.17	183.31	225.29	259.29	304.96	336.85	393.42
Aug. 1, 1908, .	133.25	142.46	158.79	163.19	200.10	168.73	177.14	184.30	225.23	259.30	304.79	336.75	390.82
Sept. 1, 1908, .	133.82	142.60	158.61	163.07	200.00	166.97	177.17	183.97	225.25	259.27	304.87	336.82	389.01
Oct. 1, 1908, .	133.56	142.44	158.29	163.10	200.09	166.95	176.93	184.42	225.04	259.30	304.62	336.64	386.05
Nov. 1, 1908, .	133.73	142.60	158.18	162.98	200.00	167.51	177.18	183.60	225.08	257.07	304.58	336.68	384.10
Dec. 1, 1908, .	134.33	141.65	158.01	163.04	199.96	167.62	175.97	183.82	224.30	251.42	304.07	336.65	383.49
Jan. 1, 1909, .	134.07	141.78	158.04	163.27	200.00	167.69	175.98	183.97	224.36	255.77	304.11	336.90	379.87

TABLE NO. 13. — *Sources from which and Periods during which Water has been drawn for the Supply of the Metropolitan Water District.*

From Wachusett Reservoir into Sudbury Reservoir.

12:30 P.M. Jan.	1 to 10:15 A.M. Jan.	5.
11:30 A.M. Jan.	21 " 7:00 A.M. May	18.
12:00 M. May	18 " 10:30 A.M. May	24.
3:40 P.M. May	24 " 10:00 A.M. May	27.
9:40 A.M. May	28 " 1:00 P.M. Oct.	22.
5:00 P.M. Oct.	28 " 8:00 A.M. Oct.	29.
2:00 P.M. Nov.	14 " 9:00 P.M. Nov.	19.
6:00 A.M. Dec.	5 " 8:30 A.M. Dec.	26.
11:15 A.M. Dec.	26 " 7:40 A.M. Dec.	28.
12:15 P.M. Dec.	28 " 7:00 A.M. Jan.	1, 1909.
Total quantity, 39,345,900,000 gallons.		

From Sudbury Reservoir through the Weston Aqueduct to the Weston Reservoir.

7:00 A.M. Jan.	1 to 7:00 A.M. Mar.	24.
9:00 A.M. Mar.	24 " 2:00 P.M. June	19.
3:00 P.M. June	20 " 7:00 A.M. Jan.	1, 1909.
Total quantity, 10,967,200,000 gallons.		

From Framingham Reservoir No. 1 through Sudbury Aqueduct to Chestnut Hill Reservoir.

December 3 and December 4.
Total quantity, 3,300,000 gallons.

From Framingham Reservoir No. 3 through Sudbury Aqueduct to Chestnut Hill Reservoir.

7:00 A.M. Jan.	1 to 11:00 P.M. Nov.	16.
4:30 P.M. Nov.	20 " 9:00 P.M. Nov.	30.
3:00 P.M. Dec.	4 " 7:00 A.M. Jan.	1, 1909.
Total quantity, 34,497,700,000 gallons.		

From Lake Cochituate through Cochituate Aqueduct to Chestnut Hill Reservoir.

7:00 A.M. Jan.	7 to 7:00 A.M. Jan.	15.
12:00 M. Feb.	1 " 7:00 A.M. Feb.	23.
11:00 A.M. Feb.	24 " 11:00 A.M. Feb.	26.
7:00 A.M. Mar.	2 " 5:00 P.M. Mar.	2.
7:00 A.M. Mar.	4 " 7:00 A.M. Mar.	5.
1:00 P.M. June	12 " 11:00 A.M. July	10.
12:00 M. July	10 " 11:00 A.M. July	20.
10:30 A.M. July	22 " 11:00 A.M. July	25.
11:00 A.M. July	28 " 11:00 A.M. July	30.
7:00 A.M. Aug.	4 " 4:00 P.M. Aug.	5.
7:00 A.M. Aug.	14 " 4:00 P.M. Aug.	15.
1:45 P.M. Sept.	25 " 4:00 P.M. Sept.	27.
11:00 A.M. Nov.	13 " 4:00 P.M. Nov.	25.
11:00 A.M. Nov.	27 " 10:30 A.M. Nov.	28.
7:00 A.M. Nov	30 " 7:00 A.M. Dec.	5.
Total quantity, 1,473,900,000 gallons.		

From Framingham Reservoir No. 3 through Sudbury Aqueduct to Lake Cochituate.

2:05 A.M. Nov. 17 to 3:30 A.M. Nov. 17.
Total quantity, 400,000 gallons.

TABLE NO. 14. — *Average Daily Quantity of Water flowing through Aqueducts in 1908 by Months.*¹

MONTH.	Wachusett Aqueduct into Sudbury Reservoir (Gallons).	Weston Aqueduct into Metro- politan District (Gallons).	Sudbury Aqueduct into Chestnut Hill Reservoir (Gallons).	Cochituate Aqueduct into Chestnut Hill Reservoir (Gallons).
January,	43,439,000	30,332,000	92,687,000	4,023,000
February,	99,134,000	29,734,000	101,534,000	12,469,000
March,	101,426,000	29,745,000	94,071,000	706,000
April,	120,797,000	29,917,000	95,570,000	—
May,	109,726,000	30,110,000	98,677,000	—
June,	124,440,000	30,063,000	99,123,000	7,580,000
July,	134,510,000	29,706,000	98,345,000	11,129,000
August,	121,487,000	29,558,000	95,087,000	1,039,000
September,	135,240,000	29,930,000	97,147,000	707,000
October,	89,261,000	29,706,000	91,110,000	—
November,	34,017,000	30,300,000	77,247,000	8,347,000
December,	175,513,000	30,474,000	90,794,000	2,887,000
Average,	107,502,000	29,965,000	94,265,000	4,027,000

¹ Not including quantities wasted while cleaning and repairing aqueducts.

TABLE No. 15. — Statement of Operations of Engines Nos. 1 and 2 at Chestnut Hill High-service Pumping Station for the Year 1908.

[3 per cent. allowed for slip.]

MONTH.	ENGINE No. 1.		ENGINE No. 2.		Total Amount pumped (Million Gallons).	Amount of Coal consumed (Pounds).	Amount of Ashes and Clinkers (Pounds).	Per Cent. of Ashes and Clinkers.	Quantity pumped per Pound of Coal, no Deduction for Heating or Lighting (Gallons).	AVERAGE LIFT (FEET).		Duty in Foot-pounds per 100 Pounds of Coal, no Deduction for Heating or Lighting; corrected for Slip.	Duty in Foot-pounds per 100 Pounds of Coal, on Basis of Plunger Displacement, no Deduction for Heating or Lighting.
	Hrs.	Min.	Total Pumping Time.	Amount pumped, corrected for Slip (Million Gallons).						Engine No. 1.	Engine No. 2.		
January,	256	15	248 25	87.69	173.38	323,814	45,570	14.1	535.43	118.92	119.56	53,180,000	54,830,000
February,	150	50	500 55	53.50	230.96	432,244	57,633	13.3	534.33	124.35	121.40	54,340,000	56,030,000
March,	300	30	123 55	105.33	148.79	279,195	37,764	13.5	532.93	119.10	120.05	52,990,000	54,640,000
April,	421	10	294 45	147.53	250.68	420,942	54,160	12.9	535.52	123.04	124.90	61,420,000	63,330,000
May,	185	20	582 40	65.47	272.40	452,042	78,297	17.3	602.60	124.16	121.99	61,500,000	63,410,000
June,	348	10	611 00	123.47	338.96	549,358	77,617	14.1	617.01	124.79	123.30	63,650,000	65,630,000
July,	408	20	475 45	145.51	312.24	513,383	74,932	14.6	608.20	122.85	122.87	62,250,000	64,190,000
August,	9	00	580 20	3.17	199.98	334,637	39,491	11.8	597.60	120.69	120.11	59,800,000	61,660,000
September,	19	25	633 30	6.84	223.79	438,711	43,558	9.9	510.11	125.87	119.77	50,970,000	52,560,000
October,	261	45	460 20	92.30	248.64	423,887	49,271	11.6	586.57	120.13	119.56	58,520,000	60,340,000
November,	72	45	479 10	25.65	187.11	331,923	29,581	8.9	563.72	125.30	120.31	56,820,000	58,530,000
December,	237	50	414 55	84.99	227.68	435,093	48,306	11.1	523.29	121.59	121.41	52,950,000	54,600,000
Total,	2,671	20	5,405 40	941.45	2,814.61	4,935,229	636,170	-	-	-	-	-	-
Average,								12.9	570.31	122.23	121.32	57,780,000	59,580,000

TABLE No. 16. — Statement of Operations of Engine No. 3 at Chestnut Hill High-service Pumping Station for the Year 1908.

[7.5 per cent. allowed for slip.]

MONTH.	Total Pumping Time.		Amount pumped, corrected for Slip, (Million Gallons).	Amount of Coal consumed (Pounds).	Amount of Ashes and Clinkers (Pounds).	Per Cent. of Ashes and Clinkers.	Quantity pumped per Pound of Coal, no Deduction for Heating or Lighting (Gallons).	Average Lift (Feet).	Duty in Foot-pounds per 100 Pounds of Coal, no Deduction for Heating or Lighting.	Duty in Foot-pounds per 100 Pounds of Coal, on Basis of Plunger Displacement, no Deduction for Heating or Lighting.
	Hrs.	Min.								
January, . . . . .	.	.	.	.	.	.	.	.	.	.
February, . . . . .	.	.	.	.	.	.	.	.	.	.
March, . . . . .	.	.	.	.	.	.	.	.	.	.
April,	238	20	221.39	249,138	44,323	17.8	888.62	133.93	99,140,000	107,120,000
May,	77	50	72.82	83,033	17,065	20.6	877.00	133.58	97,590,000	105,450,000
June, . . . . .	.	.	.	.	.	.	.	.	.	.
July, . . . . .	.	.	.	.	.	.	.	.	.	.
August, . . . . .	.	.	.	.	.	.	.	.	.	.
September, . . . . .	.	.	.	.	.	.	.	.	.	.
October, . . . . .	.	.	.	.	.	.	.	.	.	.
November,	95	30	87.72	77,022	6,749	8.8	1,138.89	129.90	123,240,000	133,160,000
December, . . . . .	.	.	.	.	.	.	.	.	.	.
Total,	411	40	381.93	409,193	68,137	-	-	-	-	-
Average, . . . . .	.	.	.	.	.	16.7	933.37	132.94	103,360,000	111,680,000

TABLE No. 17.—Statement of Operations of Engine No. 4 at Chestnut Hill High-service Pumping Station for the Year 1908.

[3 per cent. allowed for slip.]

MONTH.	Total Pumping Time.	Amount pumped, corrected for Slip (Million Gallons).	Amount of Coal consumed (Pounds).	Amount of Ashes and Clinkers (Pounds).	Per Cent. of Ashes and Clinkers.	Quantity pumped per Pound of Coal, no Deduction for Heating or Lighting (Gallons).	Average Lift (Feet).	Duty in Foot-pounds per 100 Pounds of Coal, on Basis of Heating or Lighting, corrected for Slip.	Duty in Foot-pounds per 100 Pounds of Coal, no Deduction for Heating or Lighting.	SUMMARY OF ENGINES Nos. 1, 2, 3 AND 4.	
										Total Amount pumped, corrected for Slip (Million Gallons).	Daily Average Amount pumped (Million Gallons).
January,	Hrs. Min. 740 30	941.00	852,369	129,102	15.1	1,103.98	131.22	120,670,000	124,380,000	1,114.38	35.95
February,	693 35	881.41	739,301	108,594	14.7	1,192.22	131.78	130,870,000	134,890,000	1,112.37	38.36
March,	741 30	943.77	818,310	126,589	15.5	1,153.32	131.06	125,910,000	129,780,000	1,092.56	35.24
April,	481 25	612.53	551,376	89,346	16.2	1,110.91	131.22	121,430,000	125,160,000	1,084.60	36.15
May,	666 00	845.44	743,217	119,535	16.1	1,137.54	130.94	124,070,000	127,890,000	1,190.66	38.41
June,	718 30	909.32	777,303	114,645	14.7	1,169.84	131.67	128,310,000	132,260,000	1,248.28	41.61
July,	744 00	941.25	791,871	112,196	14.2	1,188.64	131.53	130,230,000	134,230,000	1,253.49	40.44
August,	741 45	938.67	787,947	91,942	11.7	1,191.29	131.88	130,870,000	134,890,000	1,138.65	36.73
September,	717 30	908.26	715,017	74,206	10.4	1,270.26	131.06	138,680,000	142,940,000	1,132.05	37.74
October,	736 35	924.65	748,005	77,564	10.4	1,236.15	130.95	134,840,000	138,990,000	1,173.29	37.85
November,	623 15	789.05	624,054	67,478	10.8	1,264.39	128.70	135,550,000	139,720,000	1,063.88	35.46
December,	734 25	925.38	747,068	79,221	10.6	1,238.95	130.75	134,940,000	139,090,000	1,153.26	37.20
Total,	8,339 00	10,560.93	8,895,838	1,190,418	-	-	-	-	-	13,757.47	-
Average,	- -	-	-	-	13.4	1,187.18	131.09	129,640,000	133,630,000	-	37.69

TABLE No. 18. — Statement of Operations of Engines Nos. 5, 6, and 7, at Chestnut Hill Low-service Pumping Station for the Year 1908.

[3 per cent. allowed for slip.]

Month.	ENGINE No. 5.		ENGINE No. 6.		ENGINE No. 7.		Total Amount pumped (Million Gallons).	Daily Average Amount pumped (Million Gal.	Total Amount of Coal consumed (Pounds).	Per Cent. of Ashes and Clinkers.	Quantity pumped per Pound of Coal, no Deduction for Heating or Lighting (Gallons).	AVERAGE LIFT (FEET).			Duty in Foot-pounds per 100 Pounds of Coal, on Basis of Plunger Displacement, no Deduction for Heating or Lighting.
	Hrs. Min.	Amount pumped, corrected for Slip (Million Gallons).	Hrs. Min.	Amount pumped, corrected for Slip (Million Gallons).	Total Pumping Time.	Amount pumped, corrected for Slip (Million Gallons).						Engine No. 5.	Engine No. 6.	Engine No. 7.	
January, .	718 05	898.47	739 50	923.20	36 25	42.84	1,864.51	60.145	739,290	16.0	2,522.03	48.99	49.08	43.06	102,730,000
February, .	641 25	827.69	696 00	904.80	333 55	413.80	2,146.29	74.010	953,005	14.0	2,252.13	57.73	57.38	59.69	108,730,000
March, .	722 20	849.48	719 50	845.69	116 15	134.42	1,829.59	59.019	709,585	15.5	2,578.39	48.85	48.64	50.37	104,950,000
April, .	702 55	850.71	607 45	733.58	159 45	192.30	1,776.59	59.220	693,230	13.2	2,562.77	51.31	50.91	53.77	109,750,000
May, .	738 20	866.51	718 05	843.56	92 30	98.74	1,808.81	58.349	667,835	13.2	2,708.47	50.09	49.97	47.69	112,590,000
June, .	601 20	728.43	702 00	852.11	289 00	355.00	1,935.54	64.518	788,175	13.6	2,455.72	57.50	57.34	50.04	114,680,000
July, .	740 00	859.37	740 50	860.00	248 10	344.58	2,063.95	66.579	828,835	13.6	2,490.18	59.06	58.88	32.69	113,220,000
August, .	710 00	814.03	707 55	811.30	154 55	194.28	1,813.61	58.697	660,975	11.0	2,752.92	50.97	50.73	35.03	112,740,000
September, .	700 20	774.94	703 10	775.22	194 00	250.53	1,800.69	60.023	620,130	8.6	2,903.73	51.30	51.07	33.31	117,790,000
October, .	533 25	607.68	564 05	637.18	312 20	382.21	1,627.07	52.486	578,585	9.6	2,812.15	49.06	48.59	29.99	104,000,000
November, .	427 20	471.07	625 15	723.38	236 55	274.02	1,468.47	48.949	560,185	5.9	2,621.40	54.92	48.58	32.58	104,000,000
December, .	637 30	725.13	676 30	744.94	183 40	233.46	1,703.53	54.953	708,095	8.5	2,405.79	51.86	50.58	34.15	97,940,000
Total, .	7,893 00	9,273.51	8,201 15	9,654.96	2,357 50	2,916.18	21,844.65	-	8,507,925	-	-	-	-	-	-
Average, .	-	-	-	-	-	-	-	59.68	-	12.2	2,567.56	52.57	51.98	41.46	108,710,000

TABLE No. 19. — Statement of Operations of Engines Nos. 8 and 9 at Spot Pond Pumping Station for the Year 1908.

[Engine No. 8, 2.02 per cent. allowed for slip.]

MONTH.	Total Pumping Time.	Amount pumped, corrected for Ship (Million Gallons).	Amount of Coal consumed (Pounds).	Amount of Ashes and Clinkers (Pounds).	Per Cent. of Ashes and Clinkers.	Quantity pumped per Pound of Coal, no Deduction for Heating or Lighting (Gallons).	Average Lift (Feet).	Duty in Foot-pounds per 100 Pounds of Coal, no Deduction for Heating or Lighting; corrected for Ship.	Duty in Foot-pounds per 100 Pounds of Coal, on Basis of Plunger Displacement, no Deduction for Heating or Lighting.	SUMMARY OF ENGINES Nos. 8 AND 9.	
										Total Amount pumped, corrected for Ship (Million Gallons).	Daily Average Amount pumped (Million Gallons).
October,	Hrs. Min. 7 00	2,872	2,783	290	10.4	1,031.26	125.31	107,650,000	109,870,000	-	-
December,	293 45	128,210	132,976	12,376	9.3	964.16	120.43	96,720,000	98,710,000	-	-
Total or average,	300 45	131,082	135,759	12,666	9.3	965.55	120.54	96,950,000	98,950,000	-	-

[Engine No. 9, 3 per cent. allowed for slip.]

[illegible]

TABLE No. 20. — (Meter Basis.) *Average Daily Consumption of Water during the Year 1908, in the Cities and Towns supplied by the Metropolitan Water Works, including Boston, Somerville, Chelsea, Malden, Everett, Quincy, Medford, Melrose, Revere, Watertown, Arlington, Lexington, Milton, Stoneham, Winthrop, Swampscott, Belmont, Nahant and a Small Portion of Saugus. (For Consumption of Water in Whole Metropolitan Water District, see Table No. 24.)*

MONTH.	Average Daily Consumption (Gallons).	Estimated Population.	Consumption per Inhabitant (Gallons).
January,	127,607,100	941,890	136
February,	140,596,400	943,400	149
March,	124,446,600	944,910	132
April,	123,964,500	937,530	132
May,	125,802,100	938,010	134
June,	133,423,500	942,330	142
July,	131,726,500	945,510	139
August,	122,514,500	947,370	129
September,	122,966,300	948,530	130
October,	119,139,500	947,490	126
November,	113,256,700	948,150	119
December,	120,210,500	950,110	126
For the year,	125,441,000	945,360	133

In addition to the above quantities, the United States Government Reservation on Peddocks Island was supplied with 22,553,000 gallons, equivalent to a daily average rate of 61,600 gallons.

TABLE No. 21. — (Meter Basis.) *Average Daily Consumption of Water, in Gallons, from the Low-service System in 1908.*

MONTH.	SOUTHERN LOW SERVICE.	NORTHERN LOW SERVICE.	Total Low-service Consumption.
	Boston, excluding East Boston and Charlestown.	Portions of Charles- town, Somerville, Chelsea, Everett, Malden, Medford, East Boston and Arlington.	
January,	54,019,700	29,981,500	84,001,200
February,	59,602,000	34,762,000	94,364,000
March,	53,261,900	28,444,600	81,706,500
April,	51,102,300	29,466,900	80,569,200
May,	51,356,100	28,228,000	79,584,100
June,	51,692,100	30,257,000	81,949,100
July,	51,242,300	30,227,700	81,470,000
August,	49,208,700	27,994,800	77,203,500
September,	49,273,000	27,169,000	76,442,000
October,	48,364,900	25,815,300	74,180,200
November,	46,394,300	24,565,000	70,959,300
December,	50,420,600	26,129,400	76,550,000
For the year,	51,313,600	28,574,700	79,888,300

TABLE NO. 22. — (Meter Basis.) Average Daily Consumption of Water, in Gallons, from the High-service and Extra High-service Systems in 1908.

MONTH.	SOUTHERN HIGH SERVICE.	SOUTHERN EXTRA HIGH SERVICE.	NORTHERN HIGH SERVICE.	NORTHERN EXTRA HIGH SERVICE.
	Quincy, Water- town, Belmont, and Portions of Boston and Milton.	Portions of Boston and Milton.	Revere, Winthrop, Swampscott, Nahant, Stoneham, Melrose, and Portions of Boston, Chelsea, Everett, Malden, Medford, Somerville, and a Small Part of Saugus.	Lexington and Portion of Arlington.
January,	34,483,500	488,100	8,063,900	570,400
February,	36,152,300	530,900	8,915,900	633,300
March,	33,822,700	524,900	7,775,200	617,300
April,	34,267,600	567,100	7,906,200	654,400
May,	36,341,200	643,500	8,451,400	781,900
June,	39,269,600	849,600	10,335,300	1,019,900
July,	37,951,800	903,200	10,393,900	1,007,600
August,	34,962,000	694,900	8,831,500	822,600
September,	36,036,000	748,200	8,834,400	905,700
October,	36,098,400	698,000	7,396,500	766,400
November,	34,393,200	529,700	6,688,600	685,900
December,	35,880,600	500,000	6,605,400	674,500
For the year,	35,804,100	639,600	8,347,400	761,600

TABLE No. 23. — Average Daily Consumption of Water in Cities and Towns supplied from Metropolitan Works, as measured by Venturi Meters in 1908.

City or town,	MONTH.	BOSTON.			SOMERVILLE.			MALDEN.			CHELSEA.			EVERETT.			QUINCY.			MEDFORD.		
		622,760.			74,000.			40,560.			31,820.			32,320.			30,430.			21,290.		
		GALLONS.			GALLONS.			GALLONS.			GALLONS.			GALLONS.			GALLONS.			GALLONS.		
		Per Day.		Per Capita.	Per Day.		Per Capita.	Per Day.		Per Capita.	Per Day.		Per Capita.	Per Day.		Per Capita.	Per Day.		Per Capita.	Per Day.		Per Capita.
January,	.	.	.	165	101,597,700	6,493,000	89	1,669,800	42	3,665,500	94	2,707,600	85	2,765,000	93	2,037,100	97					
February,	.	.	.	179	111,014,600	7,363,100	100	1,784,600	44	4,656,200	120	3,328,900	104	2,899,800	97	2,192,800	104					
March,	.	.	.	160	99,181,300	6,298,600	86	1,670,800	41	3,506,900	90	2,511,700	78	2,702,900	90	2,018,800	96					
April,	.	.	.	156	96,850,300	6,229,800	85	1,762,700	44	5,155,300	171	2,452,100	76	2,636,600	87	2,005,300	95					
May,	.	.	.	159	98,746,100	6,604,100	90	1,974,100	49	3,161,200	115	2,533,900	79	2,941,500	97	2,212,600	104					
June,	.	.	.	164	101,846,100	7,393,600	100	2,320,300	57	3,150,500	112	2,827,100	88	3,485,100	115	2,522,200	119					
July,	.	.	.	161	100,301,000	7,284,700	98	2,167,800	53	3,060,200	107	2,794,800	86	3,558,900	117	2,496,300	117					
August,	.	.	.	152	94,946,900	6,597,800	89	1,863,400	46	2,929,600	101	2,598,800	80	3,164,800	104	2,053,800	96					
September,	.	.	.	153	95,429,500	6,446,600	87	2,050,400	50	2,707,900	91	2,640,700	81	3,221,500	105	2,070,500	97					
October,	.	.	.	151	94,172,100	6,158,300	83	1,838,700	45	2,844,600	95	2,421,100	74	3,034,900	99	1,814,800	85					
November,	.	.	.	144	89,820,900	6,013,400	81	1,663,400	41	2,635,000	86	2,289,300	70	2,906,200	94	1,717,300	80					
December,	.	.	.	155	96,910,300	6,198,500	83	1,657,800	41	2,398,700	77	2,541,100	78	2,706,800	88	1,692,900	79					
For the year,	.	.	.	158	98,379,300	6,589,200	89	1,868,600	46	3,316,900	104	2,636,300	82	3,003,600	99	2,069,000	97					

TABLE No. 23. — *Average Daily Consumption of Water in Cities and Towns, etc.* — Continued.

City or town, Population supplied,	MELROSE.					REVERE.		WATERTOWN.		ARLINGTON.		MILTON.		WINTHROP.		
	15,110.					14,580.1		12,270.		10,460.		7,560.		7,840.		
	GALLONS.					GALLONS.		GALLONS.		GALLONS.		GALLONS.		GALLONS.		
MONTH.	Per Day.	Per Capita.	Per Day.	Per Capita.	Per Day.	Per Capita.	Per Day.	Per Capita.	Per Day.	Per Capita.	Per Day.	Per Capita.	Per Day.	Per Capita.	Per Day.	Per Capita.
January,	1,568,000	105	1,133,300	79	616,600	51	759,600	73	280,100	38	749,200	97				
February,	1,535,800	102	1,412,700	99	636,200	53	893,400	86	271,100	36	851,100	110				
March,	1,395,700	93	1,140,400	79	629,000	52	767,400	74	272,300	36	774,100	100				
April,	1,414,300	94	1,115,700	77	708,000	58	835,200	80	300,900	40	823,100	106				
May,	1,492,200	99	1,272,400	88	772,200	63	927,700	89	372,100	49	868,500	111				
June,	1,631,300	111	1,555,500	107	952,200	78	1,315,700	126	450,500	60	1,093,700	140				
July,	1,599,200	106	1,694,100	116	850,600	69	1,316,500	126	421,200	56	1,222,800	156				
August,	1,271,400	84	1,484,100	102	696,000	57	1,024,600	98	351,300	46	1,115,900	142				
September,	1,283,600	85	1,365,300	93	788,800	64	1,161,000	111	390,800	51	1,062,900	135				
October,	1,096,100	72	1,126,300	76	724,600	59	938,900	89	334,800	44	919,100	116				
November,	966,400	64	1,075,000	73	696,100	56	855,000	81	280,800	37	843,500	106				
December,	924,500	61	1,140,700	77	715,500	58	861,900	82	254,400	33	819,000	103				
For the year,	1,351,900	89	1,293,100	89	732,000	60	971,200	93	331,600	44	928,700	118				

¹ Includes 280 people in Saugus.

TABLE No. 23. — Average Daily Consumption of Water in Cities and Towns, etc. — Concluded.

City or town,	STONEHAM.			BELMONT.			LEXINGTON.			NAHANT.			SWAMPSCOTT.			METROPOLITAN DISTRICT.		
	6,630.			4,690.			4,630.			1,860.			6,550.			945,360.		
	GALLONS.			GALLONS.			GALLONS.			GALLONS.			GALLONS.			GALLONS.		
MONTH.	Per Day.	Per Capita.		Per Day.	Per Capita.		Per Day.	Per Capita.		Per Day.	Per Capita.		Per Day.	Per Capita.		Per Day.	Per Capita.	
January,	671,200	102	.	241,100	52	.	216,700	48	.	78,600	84	.	357,000	64	.	127,607,100	136	.
February,	763,000	116	.	265,300	57	.	253,200	56	.	89,800	96	.	384,800	69	.	140,596,400	149	.
March,	644,400	98	.	265,100	57	.	232,900	51	.	70,000	75	.	304,300	65	.	124,446,600	132	.
April,	636,000	96	.	303,900	65	.	266,500	58	.	88,100	85	.	380,700	68	.	123,964,500	132	.
May,	614,900	93	.	360,000	77	.	346,700	75	.	127,200	88	.	474,700	72	.	125,802,100	134	.
June,	650,000	98	.	531,500	114	.	504,500	109	.	292,600	85	.	851,100	112	.	133,423,500	142	.
July,	675,600	102	.	592,700	126	.	485,800	105	.	323,100	90	.	876,200	108	.	131,726,500	139	.
August,	590,500	89	.	457,400	97	.	387,500	83	.	236,500	67	.	738,200	91	.	122,514,500	129	.
September,	613,000	92	.	446,200	95	.	424,200	91	.	190,200	59	.	673,200	88	.	122,966,300	130	.
October,	561,900	84	.	333,600	71	.	329,100	70	.	72,100	58	.	418,500	63	.	119,139,500	126	.
November,	566,700	85	.	321,400	68	.	256,300	54	.	50,800	54	.	299,200	53	.	113,256,700	119	.
December,	529,000	79	.	265,500	56	.	243,500	51	.	56,600	60	.	293,800	52	.	120,210,500	126	.
For the year,	626,000	94	.	365,400	78	.	328,800	71	.	140,100	75	.	509,300	78	.	125,441,000	133	.

TABLE NO. 24. — (*Pump Basis.*) *Consumption of Water in the Metropolitan Water District, as constituted in the Year 1908, the Town of Swampscott and a Small Section of the Town of Saugus, from 1893 to 1908.*

[Gallons per day.]

MONTH.	1893.	1894.	1895.	1896.	1897.	1898.	1899.	1900.
January, .	75,209,000	67,506,000	68,925,000	82,946,000	85,366,000	83,880,000	96,442,000	100,055,000
February, .	71,900,000	68,944,000	80,375,000	87,021,000	83,967,000	87,475,000	103,454,000	98,945,000
March, .	67,638,000	62,710,000	69,543,000	86,111,000	82,751,000	85,468,000	90,200,000	97,753,000
April, .	62,309,000	57,715,000	62,909,000	77,529,000	79,914,000	76,574,000	86,491,000	89,497,000
May, .	61,025,000	60,676,000	65,194,000	73,402,000	76,772,000	76,677,000	89,448,000	87,780,000
June, .	63,374,000	68,329,000	69,905,000	77,639,000	77,952,000	83,463,000	97,691,000	98,581,000
July, .	69,343,000	73,642,000	69,667,000	80,000,000	85,525,000	88,228,000	96,821,000	107,786,000
August, .	66,983,000	67,995,000	72,233,000	78,537,000	84,103,000	87,558,000	92,072,000	102,717,000
September, .	64,654,000	67,137,000	73,724,000	74,160,000	84,296,000	88,296,000	91,478,000	103,612,000
October, .	63,770,000	62,735,000	67,028,000	71,762,000	79,551,000	81,770,000	89,580,000	98,358,000
November, .	61,204,000	62,231,000	64,881,000	71,933,000	72,762,000	78,177,000	86,719,000	93,648,000
December, .	66,700,000	65,108,000	70,443,000	79,449,000	76,594,000	86,355,000	85,840,000	97,844,000
Average, .	66,165,000	65,382,000	69,499,000	78,360,000	80,793,000	83,651,000	92,111,000	98,059,000
Population, .	723,153	743,354	763,557	786,385	809,213	832,042	854,870	877,698
Per capita, .	91.5	88.0	91.0	99.7	99.8	100.5	107.8	111.7

MONTH.	1901.	1902.	1903.	1904.	1905.	1906.	1907.	1908.
January, .	111,275,000	118,435,000	125,176,000	137,771,000	130,878,000	126,093,000	137,730,000	132,376,000
February, .	117,497,000	117,268,000	122,728,000	143,222,000	140,595,000	130,766,000	150,822,000	146,199,000
March, .	105,509,000	108,461,000	111,977,000	123,334,000	120,879,000	123,570,000	134,202,000	128,884,000
April, .	93,317,000	103,153,000	107,179,000	108,688,000	111,898,000	118,428,000	121,556,000	128,926,000
May, .	95,567,000	106,692,000	111,589,000	111,715,000	115,804,000	122,404,000	123,502,000	131,040,000
June, .	103,420,000	110,002,000	105,590,000	111,209,000	117,441,000	121,882,000	125,623,000	139,843,000
July, .	106,905,000	108,340,000	107,562,000	113,584,000	124,769,000	118,726,000	128,779,000	138,232,000
August, .	102,815,000	107,045,000	103,570,000	112,836,000	121,158,000	120,591,000	131,098,000	128,073,000
September, .	102,103,000	107,752,000	106,772,000	114,188,000	120,103,000	121,685,000	124,751,000	129,972,000
October, .	103,389,000	106,560,000	103,602,000	108,290,000	118,301,000	116,561,000	124,051,000	124,189,000
November, .	101,324,000	105,175,000	103,477,000	108,054,000	116,693,000	113,746,000	119,627,000	117,119,000
December, .	113,268,000	125,434,000	114,721,000	125,119,000	122,696,000	130,995,000	122,407,000	124,468,000
Average, .	104,645,000	110,345,000	110,277,000	118,114,000	121,671,000	122,085,000	128,561,000	130,712,000
Population, .	892,740	907,780	922,820	937,860	953,556	965,990	986,680	995,010
Per capita, .	117.2	121.6	119.5	125.9	127.6	126.4	130.3	131.4

This table includes the water consumed in the cities and towns enumerated in Table No. 20, together with the water consumed in Newton and Hyde Park, which are included in the Metropolitan Water District, but have not been supplied from the Metropolitan Works. The populations for the years 1901 to 1904 were revised after the census of 1905 became available, and consequently the figures in the reports after 1904 differ from those published in a corresponding table in the preceding annual reports.

TABLE No. 26. — *Chemical Examinations of Water from Sudbury Reservoir.*
[Parts per 100,000.]

Number.	Date of Collection.	APPEARANCE.			ODOR.		RESIDUE ON EVAPORA- TION.		AMMONIA.				NITROGEN AS		Oxygen Consumed.	Hardness.	
		Turbidity.	Sediment.	COLOR. Platinum Standard.	Cold.	Hot.	Total.	Loss on Ignition.	Free.	ALBUMINOID.			Nitrates.	Nitrites.			
										Total.	Dissolved.	Suspended.					
69785	1908. Jan. 6	V. slight.	V. slight.	24	Faintly unpleasant and fishy.	Distinctly unpleasant and fishy.	3.35	1.15	.0032	.0116	.0108	.0008	.34	.0100	.0001	.36	1.3
70171	Feb. 3	V. slight.	Slight.	28	V. faintly vegetable.	Faintly vegetable.	4.00	1.40	.0028	.0118	.0106	.0012	.35	.0140	.0003	.37	1.4
70665	March 2	Slight.	Cons.	30	V. faintly vegetable.	Faintly vegetable.	3.10	1.10	.0034	.0142	.0102	.0040	.30	.0090	.0005	.37	1.0
71201	April 6	V. slight.	Cons.	22	V. faintly vegetable.	Faintly vegetable.	3.60	1.85	.0040	.0140	.0106	.0034	.29	.0100	.0001	.33	1.1
71572	May 4	V. slight.	Slight.	21	Faintly vegetable.	Distinctly vegetable.	3.45	1.10	.0022	.0150	.0124	.0026	.36	.0060	.0001	.37	1.1
71993	June 1	V. slight.	Slight.	18	V. faintly vegetable.	Faintly vegetable.	3.20	1.20	.0010	.0148	.0112	.0036	.33	.0030	.0001	.31	1.0
72546	July 6	V. slight.	V. slight.	16	Faintly vegetable.	Distinctly vegetable.	2.35	1.00	.0030	.0140	.0116	.0024	.40	.0020	.0000	.30	0.6
73119	Aug. 3	V. slight.	V. slight.	16	Faintly vegetable.	Faintly vegetable.	3.25	1.00	.0042	.0100	.0090	.0010	.27	.0030	.0002	.27	0.6
73768	Sept. 2	None.	V. slight.	11	Faintly unpleasant, decaying organisms.	Distinctly unpleasant, decaying organisms.	2.85	1.20	.0012	.0116	.0102	.0014	.25	.0020	.0000	.21	0.8
74394	Oct. 5	V. slight.	V. slight.	14	V. faintly vegetable.	Faintly vegetable.	2.65	1.20	.0012	.0088	.0080	.0008	.25	.0010	.0001	.19	0.5
75026	Nov. 2	V. slight.	Slight.	12	V. faintly vegetable.	Faintly vegetable.	2.70	1.30	.0024	.0104	.0078	.0026	.29	.0010	.0001	.24	0.6
75619	Dec. 1	V. slight.	Slight.	14	Faintly vegetable.	Faintly vegetable.	3.20	1.40	.0022	.0108	.0102	.0006	.25	.0010	.0000	.22	1.6
Av.	.....	.....	.....	19	.....	.....	3.14	1.24	.0026	.0123	.0102	.0020	.31	.0052	.0001	.30	1.0

TABLE No. 27. — *Chemical Examinations of Water from Spot Pond, Stoneham.*

[Parts per 100,000.]

Number.	Date of Collection.	APPEARANCE.			ODOR.		RESIDUE ON EVAPORA- TION.		AMMONIA.				NITROGEN AS		Oxygen Consumed.	Hardness.
		Turbidity.	Sediment.	COLOR. Platinum Standard.	Cold.	Hot.	Total.	Loss on Ignition.	Free.	ALBUMINOID.			Nitrates.	Nitrites.		
										Total.	Dissolved.	Suspended.					Chlorine.
69832	1908. Jan. 9	V. slight.	Slight.	11	Faintly vegetable.	Distinctly vegetable, faintly unpleasant.	3.40	1.45	.0006	.0118	.0094	.0024	.0020	.0000	.26	1.1
70287	Feb. 10	V. slight.	Slight.	16	Faintly vegetable.	Faintly vegetable.	3.80	1.00	.0022	.0128	.0104	.0024	.0040	.0000	.29	1.3
70693	March 3	Slight.	V. slight.	15	V. faintly unpleasant.	Faintly unpleasant.	2.80	1.30	.0124	.0098	.0094	.0004	.0060	.0001	.27	1.0
71236	April 8	V. slight.	Slight.	14	V. faintly vegetable and fishy.	Faintly vegetable and fishy.	3.60	1.25	.0008	.0124	.0100	.0024	.0060	.0001	.26	1.1
71644	May 7	V. slight.	Slight.	12	Faintly vegetable.	Distinctly vegetable, faintly unpleasant.	3.80	1.05	.0010	.0154	.0124	.0030	.0010	.0000	.27	1.1
72009	June 2	V. slight.	Slight.	11	Faintly vegetable.	Faintly vegetable.	3.05	1.15	.0012	.0124	.0116	.0008	.0020	.0000	.24	1.1
72664	July 13	V. slight.	V. slight.	10	Faintly vegetable.	Faintly vegetable.	3.15	1.10	.0004	.0156	.0124	.0032	.0000	.0000	.28	1.0
73169	Aug. 4	V. slight.	V. slight.	11	Distinctly vegetable.	Distinctly vegetable.	3.30	1.15	.0006	.0188	.0136	.0052	.0010	.0000	.27	1.0
73714	Sept. 1	V. slight.	V. slight.	12	Faintly vegetable.	Faintly vegetable.	4.05	1.65	.0012	.0140	.0120	.0020	.0000	.0000	.23	0.8
74544	Oct. 13	V. slight.	Slight.	11	V. faintly earthy.	Faintly earthy.	4.15	1.70	.0008	.0120	.0096	.0024	.0000	.0000	.25	1.3
75078	Nov. 5	V. slight.	V. slight.	13	Faintly vegetable.	Faintly vegetable.	3.75	1.50	.0024	.0128	.0110	.0018	.0000	.0001	.17	1.1
75690	Dec. 7	V. slight.	Slight.	10	None.	V. faintly vegetable.	2.25	1.10	.0036	.0140	.0116	.0024	.0000	.0000	.21	1.3
Av.	.....	.....	.....	12	.....	.....	3.43	1.28	.0022	.0135	.0111	.0024	.0018	.0000	.25	1.1

TABLE No. 28. — *Chemical Examinations of Water from Lake Cochituate.*

[Parts per 100,000.]

Number.	Date of Collection.	APPEARANCE.			ODOR.		RESIDUE ON EVAPORA- TION.		AMMONIA.				NITROGEN AS		Oxygen Consumed.	Hardness.
		Turbidity.	Sediment.	COLOR. Platinum Standard.	Cold.	Hot.	Total.	Loss on Ignition.	Free.	Total.	Dissolved.	Suspended.	Nitrates.	Nitrites.		
69774	1908. Jan. 6	Slight.	Cons., or- ganisms. V. slight.	27	Faintly vegetable.	Faintly vegetable.	5.00	2.15	.0008	.0212	.0122	.0090	.0020	.0001	.38	2.1
70193	Feb. 4	V. slight.		28	V. faintly vegetable.	Faintly vegetable.	6.35	1.90	.0022	.0192	.0148	.0044	.0040	.0001	.49	2.0
70658	March 2	V. slight.	Cons.	31	V. faintly vegetable.	Faintly vegetable.	5.30	2.50	.0034	.0262	.0174	.0088	.0050	.0001	.47	2.1
71195	April 6	V. slight.	Cons., or- ganisms.	34	Faintly vegetable and unpleasant.	Faintly vegetable and unpleasant.	5.00	1.25	.0022	.0232	.0176	.0036	.0080	.0000	.48	2.2
71563	May 4	Slight.	Slight.	30	Faintly vegetable and unpleasant.	Faintly vegetable and unpleasant.	4.90	1.40	.0020	.0204	.0128	.0076	.0060	.0001	.54	2.3
71998	June 1	V. slight.	Slight.	31	Faintly vegetable.	Distinctly vegetable.	5.25	2.00	.0030	.0222	.0160	.0062	.0020	.0002	.48	2.1
72553	July 6	V. slight.	Slight.	23	Faintly vegetable.	Distinctly vegetable.	4.90	1.85	.0014	.0192	.0144	.0048	.0010	.0002	.44	2.0
73142	Aug. 4	V. slight.	V. slight.	21	Distinctly vegetable.	Decidedly vegetable.	4.90	2.15	.0006	.0192	.0150	.0042	.0000	.0000	.40	2.1
73725	Sept. 1	Slight.	Cons.	20	Faintly unpleasant.	Faintly unpleasant.	6.55	2.30	.0076	.0356	.0262	.0094	.0000	.0001	.43	2.1
74409	Oct. 5	V. slight.	Slight.	20	V. faintly vegetable.	V. faintly vegetable.	5.70	2.20	.0012	.0182	.0152	.0030	.0000	.0000	.33	2.1
75031	Nov. 3	V. slight.	Slight.	20	Faintly vegetable.	Distinctly vegetable.	5.45	2.50	.0018	.0146	.0144	.0002	.0020	.0002	.36	2.1
75614	Dec. 1	V. slight.	Slight.	23	Faintly vegetable.	Distinctly vegetable.	3.80	1.85	.0074	.0166	.0144	.0022	.0020	.0001	.42	2.5
Av.	.....	.....	.....	26	.....	.....	5.26	2.00	.0028	.0213	.0159	.0055	.0027	.0001	.44	2.1

TABLE No. 29. — *Chemical Examinations of Water from a Tap at the State House, Boston.*
[Parts per 100,000.]

Number.	Date of Collection.	APPEARANCE.			ODOR.		AMMONIA.				NITROGEN AS		Oxygen Consumed.	Hardness.		
		Turbidity.	Sediment.	COLOR.	Cold.	Hot.	Free.	ALBUMINOID.			Nitrates.	Nitrites.				
								Total.	Dissolved.	Suspended.					Chlorine.	
		Total.		Loss on Ignition.												
69805	1908. Jan. 8	Slight.	Slight.	27	Faintly unpleasant and fishy.	Distinctly unpleasant and fishy.	4.10	1.70	.0016	.0178	.0110	.0068	.0100	.0001	.32	1.4
70169	Feb. 3	V. slight	V. slight.	25	Faintly vegetable.	Faintly vegetable.	4.20	1.95	.0020	.0110	.0102	.0008	.0160	.0001	.32	1.6
70656	March 2	V. slight.	Slight.	28	Distinctly vegetable.	Distinctly vegetable.	4.65	1.85	.0024	.0138	.0094	.0044	.0360	.0001	.33	1.6
71184	April 6	Slight.	Slight.	22	Faintly vegetable.	Distinctly vegetable and faintly fishy.	3.65	1.10	.0016	.0126	.0096	.0030	.0150	.0002	.27	1.1
71555	May 4	Slight.	Slight.	20	Distinctly vegetable, geranium asterionella.	Distinctly vegetable, faintly unpleasant.	3.60	1.25	.0012	.0120	.0088	.0032	.0070	.0001	.32	1.0
71979	June 1	V. slight.	Slight.	21	Distinctly vegetable, geranium.	Distinctly vegetable, geranium.	3.60	1.35	.0008	.0124	.0106	.0018	.0060	.0001	.27	1.0
72541	July 6	V. slight.	V. slight.	19	Faintly vegetable.	Distinctly vegetable.	3.65	1.15	.0008	.0124	.0104	.0020	.0060	.0000	.29	1.3
73110	Aug. 3	V. slight.	V. slight.	12	Faintly vegetable.	Faintly vegetable.	3.40	0.95	.0002	.0094	.0084	.0010	.0030	.0000	.23	0.8
73700	Aug. 31	V. slight.	V. slight.	12	V. faintly vegetable.	V. faintly vegetable.	2.80	1.15	.0006	.0094	.0080	.0014	.0050	.0000	.24	0.8
74377	Oct. 5	V. slight.	V. slight.	12	V. faintly vegetable.	Faintly vegetable.	2.40	1.05	.0006	.0088	.0074	.0014	.0020	.0000	.18	0.6
75004	Nov. 2	V. slight.	V. slight.	11	V. faintly vegetable.	V. faintly vegetable.	3.00	1.45	.0004	.0086	.0076	.0010	.0020	.0001	.15	1.0
75585	Nov. 30	V. slight.	Slight.	14	Faintly vegetable.	Faintly vegetable.	3.00	1.20	.0012	.0102	.0086	.0016	.0020	.0000	.21	1.8
Av.	.....	.....	.....	19	.....	.....	3.50	1.35	.0011	.0115	.0092	.0024	.0092	.0001	.26	1.2

TABLE No. 30. — Averages of Examinations of Water from Various Parts of the Metropolitan Water Works in 1908.
[Parts per 100,000.]

LOCALITY.	Samples Collected.	Color.	RESIDUE ON EVAPORATION.		AMMONIA.				Chlorine.	NITROGEN AS		Oxygen Consumed.	Hardness.
			Total.	Loss on Ignition.	Free.	ALBUMINOID.				Nitrates.	Nitrites.		
						Total.	Dis- solved.	Sus- pended.					
Quinepoxet River, Holden,	Semi-monthly,	36	3.30	1.33	.0016	.0147	.0121	.0026	.26	.0042	.0001	.44	0.6
Stillwater River, Sterling,	Semi-monthly,	29	3.30	1.34	.0013	.0128	.0106	.0022	.21	.0019	.0000	.35	0.7
Wachusett Reservoir, West Boylston,	Semi-monthly,	24	3.46	1.49	.0018	.0133	.0109	.0024	.24	.0023	.0001	.34	0.6
Wachusett Reservoir, Clinton, surface,	Semi-monthly,	17	2.97	1.28	.0019	.0123	.0103	.0020	.25	.0019	.0001	.28	0.7
Wachusett Reservoir, Clinton, bottom,	Semi-monthly,	19	2.88	1.21	.0017	.0101	.0083	.0018	.25	.0039	.0001	.30	0.7
Marlborough (Walker's Brook),	Monthly,	61	17.61	5.01	.3639	.0431	.0323	.0108	2.57	.1075	.0133	.75	6.1
Marlborough Brook filter-beds, effluent, 1.	Monthly,	9	14.11	-	.0297	.0124	-	-	1.57	.2243	.0004	.27	4.7
Wachusett Aqueduct, Southborough,	Monthly,	25	3.37	1.35	.0020	.0110	.0038	.0012	.26	.0049	.0001	.35	0.9
Sudbury Reservoir, surface,	Monthly,	19	3.14	1.24	.0026	.0123	.0102	.0020	.31	.0052	.0001	.30	1.0
Sudbury Reservoir, bottom,	Monthly,	19	3.44	1.34	.0032	.0121	.0098	.0023	.31	.0064	.0002	.29	1.0
Framingham Reservoir, No. 3, inlet,	Monthly,	19	3.71	1.48	.0018	.0113	.0095	.0018	.30	.0062	.0001	.29	1.1
Framingham Reservoir, No. 3, near dam,	Monthly,	19	3.14	1.30	.0018	.0132	.0104	.0020	.30	.0052	.0001	.31	1.1
Hopkinton Reservoir, inlet,	Monthly,	107	5.63	2.62	.0027	.0248	.0227	.0022	.49	.0013	.0000	1.12	1.2
Hopkinton Reservoir, surface,	Monthly,	54	3.98	1.59	.0022	.0164	.0142	.0022	.37	.0023	.0001	.64	0.9
Hopkinton Reservoir, bottom,	Monthly,	54	3.80	1.52	.0023	.0143	.0128	.0015	.37	.0065	.0001	.63	0.9
Ashland Reservoir, inlet,	Monthly,	82	4.88	2.12	.0023	.0220	.0193	.0027	.38	.0026	.0001	.82	1.1
Ashland Reservoir, surface,	Monthly,	56	4.10	1.77	.0022	.0184	.0161	.0023	.32	.0014	.0001	.63	0.8
Ashland Reservoir, bottom,	Monthly,	58	3.99	1.79	.0028	.0159	.0140	.0019	.32	.0026	.0001	.63	0.9
Framingham Reservoir, No. 2, inlet,	Monthly,	62	4.88	1.95	.0032	.0205	.0173	.0033	.41	.0036	.0001	.66	1.2
Framingham Reservoir No. 2, near dam,	Monthly,	63	4.21	1.75	.0029	.0201	.0172	.0029	.36	.0026	.0001	.66	1.1
Lake Cochituate, surface,	Monthly,	26	5.26	2.00	.0028	.0213	.0159	.0055	.59	.0027	.0001	.44	2.1
Lake Cochituate, bottom,	Monthly,	77	6.31	2.40	.0399	.0218	.0170	.0049	.58	.0038	.0003	.54	2.3
Dug Pond,	Monthly,	13	5.14	1.89	.0033	.0189	.0160	.0029	.67	.0057	.0001	.26	1.9
Weston Reservoir,	Monthly,	18	3.42	1.36	.0015	.0117	.0098	.0019	.30	.0068	.0001	.29	1.0
Terminal chamber, Sudbury Aqueduct,	Monthly,	19	3.58	1.37	.0019	.0119	.0099	.0020	.31	.0060	.0001	.29	1.0
Spot Pond,	Monthly,	12	3.43	1.28	.0022	.0135	.0111	.0024	.35	.0018	.0000	.25	1.1
Tap in Revere,	Monthly,	13	3.89	1.56	.0010	.0120	.0104	.0017	.35	.0023	.0000	.24	1.3
Tap at State House,	Monthly,	19	3.50	1.35	.0011	.0115	.0092	.0024	.33	.0092	.0001	.26	1.2
Tap in Quincy,	Monthly,	17	3.56	1.37	.0009	.0093	.0084	.0009	.34	.0076	.0001	.24	1.2

1 Average of 7 samples.

TABLE NO. 31.—*Chemical Examinations of Water from a Faucet in Boston, from 1892 to 1908.*

[Parts per 100,000.]

YEAR.	COLOR.		RESIDUE ON EVAPORATION.		AMMONIA.				Chlorine.	NITROGEN AS		Oxygen Consumed.	Hardness.
	Nessler Standard.	Platinum Standard.	Total.	Loss on Ignition.	Free.	ALBUMINOID.		Nitrates.		Nitrites.			
						Total.	Dis- solved.				Sus- pended.		
1892, . .	.37	37	4.70	1.67	.0007	.0168	.0138	.0030	.41	.0210	.0001	-	1.9
1893, . .	.61	53	4.54	1.84	.0010	.0174	.0147	.0027	.38	.0143	.0001	.60	1.8
1894, . .	.69	58	4.64	1.83	.0006	.0169	.0150	.0019	.41	.0106	.0001	.63	1.7
1895, . .	.72	59	4.90	2.02	.0006	.0197	.0175	.0022	.40	.0171	.0001	.69	0.7
1896, . .	.49	45	4.29	1.67	.0005	.0165	.0142	.0023	.37	.0155	.0001	.56	1.4
1897, . .	.65	55	4.82	1.84	.0009	.0193	.0177	.0016	.40	.0137	.0001	.64	1.6
1898, . .	.41	40	4.19	1.60	.0008	.0152	.0136	.0016	.29	.0097	.0001	.44	1.4
1899, . .	.23	28	3.70	1.30	.0006	.0136	.0122	.0014	.24	.0137	.0001	.35	1.1
1900, . .	.24	29	3.80	1.20	.0012	.0157	.0139	.0018	.25	.0076	.0001	.38	1.3
1901, . .	.24	29	4.43	1.64	.0013	.0158	.0142	.0016	.30	.0173	.0001	.42	1.7
1902, . .	.26	30	3.93	1.56	.0016	.0139	.0119	.0020	.29	.0092	.0000	.40	1.3
1903, . .	.25	29	3.98	1.50	.0013	.0125	.0110	.0015	.30	.0142	.0001	.39	1.5
1904, . .	-	23	3.93	1.59	.0023	.0139	.0121	.0018	.34	.0110	.0001	.37	1.5
1905, . .	-	24	3.86	1.59	.0020	.0145	.0124	.0021	.35	.0083	.0001	.35	1.4
1906, . .	-	24	3.86	1.39	.0018	.0159	.0134	.0025	.34	.0054	.0001	.36	1.3
1907, . .	-	22	3.83	1.40	.0013	.0129	.0109	.0020	.33	.0068	.0001	.32	1.3
1908, . .	-	19	3.50	1.35	.0011	.0115	.0092	.0024	.33	.0092	.0001	.26	1.2

Note relating to Chemical Examinations of Water, Tables Nos. 25-31.

The chemical examinations contained in the tables were made by the State Board of Health. Previous to the year 1904 colors were determined by the Nessler standard, but the corresponding values by the platinum standard are also given, for the purpose of comparison with colors determined in the laboratory of the Metropolitan Water and Sewerage Board, as given in subsequent tables. The odor recorded is taken in such a way that it is a much stronger odor than would be noticed in samples drawn directly from a tap or collected directly from a reservoir. The important samples are collected and examined semi-monthly or monthly.

TABLE No. 32.—*Colors of Water from Various Parts of the Metropolitan Water Works in 1908. (Means of Weekly Determinations.)*

[Platinum Standard.]

MONTH.	WACHUSETT RESERVOIR.						SUDBURY RESERVOIR.				FRAMINGHAM RESERVOIRS.		LAKE COCHITUATE.			
	Surface.	Mid-depth.	Bottom.	Worcester Street Bridge.	Quinepoxet River.	Stillwater River.	Surface.	Mid-depth.	Bottom.	End of Open Channel.	No. 2.	No. 3.	Surface.	Mid-depth.	Bottom.	Influent Streams. ¹
January, . . .	29	28	29	42	44	40	30	30	30	62	72	31	32	31	31	79
February, . . .	28	28	29	37	40	36	31	31	31	33	66	31	33	33	37	64
March, . . .	24	24	24	30	32	29	26	26	26	30	53	26	34	34	38	67
April, . . .	22	22	23	29	35	31	23	24	24	26	63	24	34	35	36	88
May, . . .	21	21	21	38	52	47	23	23	23	24	77	23	34	37	38	138
June, . . .	21	21	22	35	59	53	23	23	23	25	106	22	31	36	59	141
July, . . .	20	20	21	22	45	33	20	21	21	21	95	21	29	36	121	107
August, . . .	18	19	21	23	56	36	19	19	21	21	80	19	24	36	182	80
September, . . .	16	18	22	20	41	32	17	17	21	20	72	17	23	42	211	56
October, . . .	15	15	19	17	36	26	16	16	17	17	62	16	23	32	232	51
November, . . .	13	14	14	15	33	34	14	14	15	15	51	15	27	27	114	42
December, . . .	14	15	15	21	49	36	16	16	17	16	50	16	29	28	28	46
Mean, . . .	20	20	22	27	44	36	22	22	22	26	71	22	29	34	94	80

¹ The colors given in this column represent the combined colors of the waters of the four principal feeders. The color of each is determined monthly, and due weight is given, in combining the results, to the sizes of the streams.

TABLE No. 32—*Concluded.*

[Platinum Standard.]

MONTH.	CHESTNUT HILL RESERVOIR.			SPOT POND.	FELLS RESERVOIR.	NORTHERN SERVICE.		SOUTHERN SERVICE.	
	Inlet (Sudbury Aqueduct).	Inlet (Cochituate Aqueduct).	Effluent Gate-house No. 2.			Tap at Glenwood Yard, Medford (Low Service).	Tap at Fire Station, Hancock Street, Everett (High Service).	Tap at 244 Boylston Street, Boston (Low Service).	Tap at 1 Ashburton Place, Boston (High Service).
January, . . .	31	30	30	15	15	30	15	29	30
February, . . .	31	32	31	16	16	30	16	29	30
March, . . .	26	-	26	14	14	25	14	25	25
April, . . .	24	-	24	15	15	24	14	23	24
May, . . .	23	-	23	14	14	23	14	23	23
June, . . .	23	31	23	16	16	23	16	23	23
July, . . .	21	29	21	14	14	21	15	21	22
August, . . .	19	21	19	15	15	19	15	19	19
September, . . .	17	-	17	14	14	17	14	17	17
October, . . .	16	-	16	13	13	16	14	16	16
November, . . .	15	29	16	13	13	16	13	15	16
December, . . .	16	28	16	14	14	16	14	15	16
Mean, . . .	22	29	22	14	14	22	15	21	22

TABLE NO. 33.—*Temperatures of Water from Various Parts of the Metropolitan Water Works in 1908. (Means of Weekly Determinations.)*

[The temperatures are taken at the same places and times as the samples for microscopical examination; the depth given for each reservoir is the depth from high-water mark.]

[Degrees Fahrenheit.]

MONTH.	WACHUSETT RESERVOIR.			SUDBURY RESERVOIR (DEPTH AT PLACE OF OBSERVATION 54.5 FEET).				FRAMINGHAM RESERVOIR No. 3 (DEPTH AT PLACE OF OBSERVATION 20.5 FEET).			LAKE COCHITUATE (DEPTH AT PLACE OF OBSERVATION 62.0 FEET).		
	Surface.	Mid-depth.	Bottom.	Surface.	Mid-depth.	Bottom.	End of Open Channel.	Surface.	Mid-depth.	Bottom.	Surface.	Mid-depth.	Bottom.
January, .	33.3	34.0	34.5	32.9	33.5	34.1	34.1	34.5	34.8	34.8	33.5	35.0	35.5
February, .	33.8	34.8	35.8	33.4	34.0	34.8	32.9	34.9	35.1	35.1	34.4	34.8	35.0
March, .	35.2	35.8	37.0	36.7	37.3	37.6	35.7	39.3	38.4	38.5	37.8	37.7	37.7
April, .	40.8	40.3	41.5	45.1	44.4	44.3	42.3	46.3	46.8	46.2	44.4	44.3	44.1
May, .	53.3	50.3	49.5	60.8	55.3	53.1	51.4	61.1	60.2	58.3	59.3	49.6	45.3
June, .	69.1	53.4	50.8	73.1	63.5	59.5	54.1	74.4	73.8	72.8	74.7	52.5	45.9
July, .	75.3	54.5	50.8	76.6	68.0	65.3	57.1	77.4	77.4	76.9	78.3	51.3	47.0
August, .	73.3	54.8	51.0	73.5	69.6	64.9	58.3	74.5	74.4	73.7	75.5	49.8	45.6
September, .	66.8	57.6	51.2	66.1	64.8	63.3	60.2	66.9	67.0	66.4	67.5	50.0	44.5
October, .	60.5	58.3	51.5	58.0	58.4	58.2	57.5	57.0	57.0	57.0	59.3	53.3	44.8
November, .	47.5	47.4	47.3	44.6	44.6	44.8	43.5	43.6	43.5	43.6	46.4	46.0	43.9
December, .	33.8	38.9	39.0	36.9	37.5	38.3	38.0	37.1	37.1	37.3	38.1	41.8	41.8
Mean, .	52.3	46.7	45.0	53.1	50.9	49.9	47.1	53.9	53.8	53.4	54.1	45.5	42.6

TABLE NO. 33 — *Concluded.*

[Degrees Fahrenheit.]

MONTH.	CHESTNUT HILL RESERVOIR.	SPOT POND (DEPTH AT PLACE OF OBSERVATION 28.0 FEET).			NORTHERN SERVICE.		SOUTHERN SERVICE.	
	Effluent Gate-house No. 2.	Surface.	Mid-depth.	Bottom.	Tap at Glenwood Yard, Medford (Low Service).	Tap at Fire Station, Hancock Street, Everett (High Service).	Tap at 244 Boylston Street, Boston (Low Service).	Tap at 1 Ashburton Place, Boston (High Service).
January, . . .	34.6	33.4	33.8	33.8	38.3	37.0	37.3	38.7
February, . . .	34.6	33.9	34.1	34.3	37.0	36.8	37.4	37.7
March, . . .	39.1	38.2	38.2	38.4	38.0	38.4	40.9	41.1
April, . . .	46.4	45.3	44.9	44.6	44.8	45.3	48.8	48.8
May, . . .	57.2	57.0	55.8	54.6	55.8	57.0	59.0	59.0
June, . . .	71.2	71.0	69.7	59.0	66.8	68.2	70.6	71.2
July, . . .	76.9	76.4	75.6	65.1	73.5	74.0	72.8	75.7
August, . . .	74.9	74.4	74.3	70.8	71.9	72.8	74.1	74.6
September, . . .	68.2	67.6	67.5	67.5	66.8	67.4	68.3	67.6
October, . . .	59.9	59.6	59.6	59.5	61.0	60.8	60.8	62.6
November, . . .	45.5	45.8	45.8	45.8	52.3	49.8	48.9	47.9
December, . . .	38.9	37.9	38.2	38.3	42.8	42.6	42.0	41.8
Mean, . . .	54.0	53.4	53.1	51.0	54.1	54.2	55.1	55.6

TABLE No. 34.—*Temperatures of the Air at Three Stations on the Metropolitan Water Works in 1908.*

[Degrees Fahrenheit.]

MONTH.	CHESTNUT HILL RESERVOIR.			FRAMINGHAM.			CLINTON.		
	Maximum.	Minimum.	Mean.	Maximum.	Minimum.	Mean.	Maximum.	Minimum.	Mean.
January, . . .	55.0	—2.0	29.6	54.0	—9.0	28.0	53.0	—6.0	26.3
February, . . .	58.0	—3.0	25.7	55.0	—10.0	22.6	58.0	—7.0	20.8
March, . . .	70.0	13.0	38.3	71.0	7.0	35.8	70.0	10.0	33.5
April, . . .	85.0	21.0	47.4	85.0	14.0	45.3	84.0	13.0	44.2
May, . . .	88.0	35.0	60.1	87.0	30.0	57.9	85.0	34.0	58.3
June, . . .	91.0	41.0	69.6	91.0	36.0	66.7	90.0	38.0	67.9
July, . . .	101.0	49.0	76.1	99.0	42.0	72.4	95.0	52.0	73.4
August, . . .	91.0	40.0	69.4	90.0	34.0	66.0	88.0	40.0	66.5
September, . . .	88.0	38.0	65.3	85.0	31.0	61.4	85.0	32.0	63.4
October, . . .	84.0	26.0	55.1	82.0	24.0	52.8	84.0	21.0	52.1
November, . . .	62.0	21.0	41.4	61.0	21.0	40.3	60.0	19.0	38.3
December, . . .	66.0	7.0	31.8	60.0	5.0	29.9	63.0	2.0	27.7
Average, . . .	—	—	50.8	—	—	48.3	—	—	47.7

TABLE No. 35. — *Table showing Length of Main Lines of Water Pipes and Connections owned and operated by Metropolitan Water and Sewerage Board, and Number of Valves set in Same, Dec. 31, 1908.*

	DIAMETER OF PIPES IN INCHES.													Total.
	60	48	42	36	30	24	20	16	14	12	10	8	6	
Total length owned and operated January 1, 1908 (feet),	9,069	171,163	8,075	46,638	26,922	46,654	57,260	54,565	26	19,437	614	1,633	877	442,933
Gate valves in same,	-	42	-	41	28	39	37	62	1	74	13	15	15	367
Air valves in same,	5	102	3	35	4	19	34	29	-	9	-	-	-	240
Length laid or relaid during 1908 (feet),	-	3,482	-	196	5	-	4	483	-	10	7	-	38	4,225
Gate valves in same,	-	3	-	-	-	-	-	1	-	1	-	-	2	7
Air valves in same,	-	4	-	-	-	-	-	-	-	-	-	-	-	4
Length abandoned during 1908 (feet),	-	11	-	98	-	-	4	-	-	11	23	5	12	164
Gate valves in same,	-	-	-	-	-	-	-	-	-	1	1	-	-	2
Air valves in same,	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Length owned and operated January 1, 1909 (feet),	9,069	174,634	8,075	46,736	26,927	46,654	57,260	55,048	26	19,436	598	1,628	903	446,994
Gate valves in same,	-	45	-	41	28	39	37	63	1	74	12	15	17	372
Air valves in same,	5	106	3	35	4	19	34	29	-	9	-	-	-	244

¹ 84.65 miles.

TABLE No. 36. — *Statement of Cast-iron Hydrant, Blow-off and Drain Pipes, owned and operated by Metropolitan Water and Sewerage Board, Dec. 31, 1908.*

	DIAMETER OF PIPES IN INCHES.								Total.
	24	20	16	12	10	8	6	4	
Total length in use December 31, 1908 (feet), . . .	352	293	2,250	4,489	173	315	2,689	1,167 *	11,728
Total valves in use December 31, 1908, . . .	-	-	18	78	1	1	56	38	192

TABLE No. 37. — *Length of Water Pipes, Four Inches in Diameter and Larger, in the Several Cities and Towns supplied by the Metropolitan Water Works, Dec. 31, 1908.*

BY WHOM OWNED.	INCHES.														TOTAL.						
	60	48	42	40	36	30	28	24	20	18	16	14	12	10	8	7	6	5	4	Feet.	Miles.
Metropolitan Water Works.	9,069	174,634	8,075	-	46,736	26,927	-	46,654	57,260	-	55,048	26	19,436	598	1,628	-	903	-	-	446,994	84.65
Boston, .	-	38,908	16,813	23,104	43,473	90,114	244	77,453	95,714	-	208,913	-	1,224,504	171,673	624,631	-	1,282,979	-	69,344	3,967,867	751.49
Somerville, .	-	-	-	-	-	-	-	-	3,596	387	3,537	8,037	80,651	49,213	95,584	-	200,025	-	20,456	461,486	87.40
Malden, .	-	-	-	-	-	-	-	-	-	-	-	9,152	64,216	27,144	73,862	-	206,542	-	64,153	445,069	84.30
Chelsea, .	-	-	-	-	-	-	-	-	-	-	2,380	-	-	39,820	27,009	-	134,977	-	8,711	212,897	40.32
Everett, .	-	-	-	-	-	-	-	2,484	2,900	-	2,233	806	5,570	39,346	20,003	-	135,076	-	30,816	239,234	45.31
Quincy, .	-	-	-	-	-	-	-	-	2,679	-	2,232	-	26,104	32,166	93,373	994	236,124	948	100,896	516,516	97.82
Medford, .	-	-	-	-	-	-	-	-	673	-	6,775	9,598	26,452	37,738	73,082	-	101,020	-	33,291	288,629	54.66
Melrose, .	-	-	-	-	-	-	-	-	-	-	5,223	2,920	25,920	15,794	24,249	-	126,032	-	52,539	252,677	47.86
Revere, .	-	-	-	-	-	-	-	-	-	-	22,650	5,700	15,200	17,050	17,355	-	52,370	-	72,973	203,298	38.50
Watertown, .	-	-	-	-	-	-	-	-	-	-	400	11,877	5,959	4,644	19,511	-	115,959	-	12,666	171,016	32.40
Arlington, .	-	-	-	-	-	-	-	-	-	-	-	-	31,804	21,621	31,497	-	84,409	-	23,812	193,143	36.58
Milton, .	-	-	-	-	-	-	-	-	-	-	103	44	22,437	19,954	46,306	-	110,802	-	15,326	214,972	40.72
Winthrop, .	-	-	-	-	-	-	-	-	-	-	-	-	4,019	6,636	22,349	-	30,045	-	74,609	137,658	26.07
Stoneham, .	-	-	-	-	-	-	-	-	-	-	-	-	4,525	4,725	2,975	-	91,750	-	13,438	117,413	22.24
Belmont, .	-	-	-	-	-	-	-	-	-	-	-	-	2,389	12,702	14,436	-	79,809	-	283	109,619	20.76
Lexington, .	-	-	-	-	-	-	-	-	-	-	-	-	9,000	2,664	8,800	-	63,080	-	33,790	117,334	22.22
Nahant, .	-	-	-	-	-	-	-	-	-	-	-	-	150	11,550	4,800	-	32,740	-	38,058	87,298	16.53
Swampscott, .	-	-	-	-	-	-	-	-	-	-	-	-	12,072	17,163	9,738	-	52,345	-	9,110	100,428	19.02
Total feet, .	9,069	213,542	24,888	23,104	90,209	117,041	244	126,591	162,822	387	330,494	48,160	1,580,408	532,201	1,211,188	994	3,136,987	948	674,271	8,283,548	-
Total miles, .	1.72	40.44	4.71	4.38	17.08	22.17	0.05	23.97	30.84	0.07	62.60	9.12	299.32	100.79	229.39	0.19	594.13	0.18	127.70	-	1,568.85

1 Including small portion of Saugus.

TABLE NO. 38.—*Number of Service Pipes, Meters and Fire Hydrants in the Several Cities and Towns supplied by the Metropolitan Water Works, Dec. 31, 1908, and the Number of Services and Meters installed during the Year 1908.*

CITY OR TOWN.	Services.	Meters.	Fire Hydrants.	Services Installed.	Meters Installed.
Boston,	94,960	5,372	8,222	1,177	182
Somerville,	11,817	4,325	1,038	169	879
Malden,	7,137	6,872	433	116	101
Chelsea,	4,000	1,357	329	106	285
Everett,	5,239	504	520	78	388
Quincy,	6,403	1,913	735	312	433
Medford,	4,510	1,495	525	132	953
Melrose,	3,481	3,481	309	52	2,461
Revere, ¹	3,073	297	160	146	134
Watertown,	1,919	1,919	335	33	33
Arlington,	1,979	992	380	65	157
Milton,	1,339	1,339	330	54	54
Winthrop,	2,167	387	157	104	317
Stoneham,	1,359	174	115	28	144
Belmont,	835	835	168	57	57
Lexington,	741	245	115	39	149
Nahant,	420	130	75	10	40
Swampscott,	1,355	1,209	133	53	317
Total,	152,734	32,846	14,079	2,731	7,084

¹ Includes small portion of Saugus.

TABLE No. 39. — Average Maximum and Minimum Monthly Heights, in Feet, above Boston City Base, to which Water rose, at Different Stations on the Metropolitan Water Works¹ in 1908.

1908. Month.	LOW-SERVICE.										SOUTHERN HIGH-SERVICE.								
	BOSTON ENGINE HOUSE, BULFINCH STREET.		ALLSTON ENGINE HOUSE, HARVARD STREET.		MEDFORD, MYSTIC RESERVOIR.		MEDFORD, WATER WORKS OFFICE, HIGH STREET.		SOMERVILLE CITY HALL ANNEX, WALNUT STREET.		MALDEN WATER WORKS SHOP, GREEN STREET.		CHELSEA COURT HOUSE. ¹		BOSTON METRO- POLITAN WATER WORKS OFFICE, 1 ASHBURTON PLACE.		WATERTOWN WATER WORKS OFFICE, MAIN STREET.		
	Maximum.	Minimum.	Maximum.	Minimum.	Maximum.	Minimum.	Maximum.	Minimum.	Maximum.	Maximum.	Minimum.	Maximum.	Minimum.	Maximum.	Maximum.	Minimum.	Maximum.	Minimum.	Maximum.
January, .	128	120	184	172	168	164	168	164	169	163	162	162	159	158	248	235	263	259	254
February, .	123	115	185	174	167	164	167	164	169	163	163	163	160	154	247	234	262	258	252
March, .	130	121	184	173	168	164	168	165	169	162	165	161	160	160	249	235	262	258	252
April, .	131	122	185	172	168	164	169	164	169	163	164	160	160	-	248	235	259	252	251
May, .	131	121	184	173	168	164	167	163	169	163	164	161	161	-	248	233	260	251	245
June, .	132	119	186	174	168	164	167	162	169	163	164	161	161	-	246	230	259	245	247
July, .	131	120	185	176	168	164	167	162	169	164	164	162	162	-	247	232	260	247	247
August, .	131	123	184	173	168	164	167	163	168	162	164	162	162	-	247	234	262	253	253
September, .	134	122	182	173	168	164	167	163	168	161	164	162	162	-	247	233	264	255	253
October, .	135	125	182	171	168	164	167	164	168	160	164	161	161	163	248	233	264	257	257
November, .	138	125	183	172	167	164	167	164	168	162	164	162	162	164	249	235	264	257	257
December, .	133	122	184	174	167	164	167	165	168	162	164	162	162	163	247	234	264	257	254
Averages,	131	121	184	173	168	164	167	164	169	162	164	161	161	160	248	234	262	254	254

¹ Recording gage in Water Works Office destroyed by fire April 12. New gage installed in Court House October 29.

TABLE No. 39. — Average Maximum and Minimum Monthly Heights, in Feet, above Boston City Base, etc. — Concluded.

1908. MONTH.	SOUTHERN HIGH-SERVICE — Concluded.								NORTHERN HIGH-SERVICE.								NORTHERN EXTRA HIGH-SERVICE.			
	BELMONT WATER WORKS SHOP, WAVERLEY STREET. ¹		MILTON WATER WORKS OFFICE, ADAMS STREET.		FORBES HILL TOWER, QUINCY.		QUINCY WATER WORKS SHOP.		SOMERVILLE PUMPING STA- TION, CEDAR STREET.		MALDEN CITY HALL.		REVERE WATER WORKS OFFICE, BROADWAY.		LYNN ENGINE HOUSE, UNION SQUARE.		WINTHROP WATER WORKS OFFICE, WIN- THROP AVENUE.		Maximum.	Minimum.
	Maximum.	Minimum.	Maximum.	Minimum.	Maximum.	Minimum.	Maximum.	Minimum.	Maximum.	Minimum.	Maximum.	Minimum.	Maximum.	Minimum.	Maximum.	Minimum.	Maximum.	Minimum.		
January, .	256	250	246	236	-	-	238	222	268	256	272	267	262	248	259	248	188	160	378	366
February, .	257	249	245	235	-	-	235	219	267	254	271	266	258	246	254	243	184	156	377	364
March, .	256	250	248	236	-	-	239	221	269	258	272	266	262	252	261	250	188	154	385	372
April, .	255	248	248	237	-	-	239	221	269	257	271	266	264	250	260	246	185	152	386	372
May, .	259	247	245	232	-	-	237	213	269	253	270	264	262	244	260	237	198	149	386	368
June, .	259	235	244	229	-	-	233	202	269	245	269	262	257	213	246	196	185	133	386	357
July, .	260	234	245	231	-	-	233	201	268	245	269	262	250	210	238	192	180	125	386	360
August, .	263	246	245	235	245	231	238	215	270	255	269	262	258	223	253	208	179	132	386	364
September, .	264	244	245	233	245	228	237	211	269	251	269	262	260	230	256	217	182	137	386	359
October, .	264	247	246	234	245	231	238	214	270	256	270	265	262	244	260	243	187	147	386	366
November, .	264	248	247	235	241	230	240	217	271	259	272	265	263	246	262	244	190	151	385	372
December, .	264	249	246	236	240	233	239	221	272	259	272	265	265	252	261	249	188	153	384	367
Averages, .	260	246	246	234	243	231	237	215	269	254	271	264	260	238	256	231	187	146	384	366

¹ Location of Belmont recording gage changed from Town Hall to Water Works Shop May 12.

APPENDIX No. 3.

WATER WORKS STATISTICS FOR THE YEAR 1908.

The Metropolitan Water Works supply the Metropolitan Water District, which includes the following cities and towns:—

CITY OR TOWN.	Population, Census of 1905.	Estimated Population July 1, 1908.
Boston,	595,380	622,760
Somerville,	69,272	74,000
Malden,	38,037	40,560
Chelsea,	37,289	28,600
Newton, ¹	36,827	39,000
Everett,	29,111	32,320
Quincy,	28,076	30,430
Medford,	19,686	21,290
Hyde Park, ¹	14,510	15,200
Melrose,	14,295	15,110
Revere,	12,659	14,300
Watertown,	11,258	12,270
Arlington,	9,668	10,460
Milton,	7,054	7,560
Winthrop,	7,034	7,840
Stoneham,	6,332	6,630
Lexington,	4,530	5,130
Belmont,	4,360	4,690
Nahant,	922	940
Total population of Metropolitan Water District, . .	946,300	989,090
Swampscott, ²	5,141	5,640
Saugus, ³	200	280

¹ No water supplied to these places during the year from Metropolitan Water Works.
² Not in the Metropolitan Water District, but has been supplied with water from the Metropolitan Water Works.
³ Only a small portion of Saugus is supplied with water.

Mode of Supply.

24 per cent. by gravity.
76 per cent. by pumping.

Pumping.

Chestnut Hill High-service Station:—

Builders of pumping machinery, Holly Manufacturing Company, Quintard Iron Works and E. P. Allis Company.

Description of coal used:— Bituminous: New River, Peerless, Barnet, Vulcan and Juniata. Anthracite: buckwheat. Price per gross ton in bins: bituminous \$3.93 to \$4.18, buckwheat \$2.80 to \$2.90. Average price per gross ton \$3.76. Per cent. ashes, 13.3.

Chestnut Hill Low-service Station:—

Builders of pumping machinery, Holly Manufacturing Company.
Description of coal used:— Bituminous: Barnet and Vulcan. Anthracite: buckwheat. Price per gross ton in bins: bituminous \$4.03 to \$4.34, buckwheat \$2.70. Average price per gross ton \$3.70. Per cent. ashes, 12.2.

Spot Pond Station:—

Builders of pumping machinery, Geo. F. Blake Manufacturing Company and Holly Manufacturing Company.
Description of coal used:— Bituminous: Davis and Georges Creek Cumberland. Anthracite: screenings. Price per gross ton in bins: bituminous \$4.14 and \$5, screenings \$2.24. Average price per gross ton \$3.59. Per cent. ashes, 13.9.

	CHESTNUT HILL HIGH-SERVICE STATION.		
	Engines Nos. 1 and 2.	Engine No. 3.	Engine No. 4.
Daily pumping capacity (gallons),	16,000,000	20,000,000	30,000,000
Coal consumed for year (pounds),	4,935,229	409,193	8,895,838
Cost of pumping, figured on pumping station expenses, . . .	\$18,898.24	\$1,286.58	\$33,272.92
Total pumpage for year, corrected for slip (million gallons), .	2,814.61	381.93	10,560.93
Average dynamic head (feet),	121.62	132.94	131.09
Gallons pumped per pound of coal,	570.31	933.37	1,187.18
Duty on basis of plunger displacement,	59,580,000	111,680,000	133,630,000
Cost per million gallons raised to reservoir,	\$6.714	\$3.369	\$3.151
Cost per million gallons raised one foot,	0.055	0.025	0.024

	CHESTNUT HILL LOW-SERVICE STATION.	SPOT POND STATION.
	Engines Nos. 5, 6 and 7.	Engines Nos. 8 and 9.
Daily pumping capacity (gallons),	105,000,000	30,000,000
Coal consumed for year (pounds),	8,507,925	2,706,751
Cost of pumping, figured on pumping station expenses, . .	\$35,610.44	\$14,416.75
Total pumpage for year, corrected for slip (million gallons), .	21,844.65	3,040.51
Average dynamic head (feet),	50.83	129.92
Gallons pumped per pound of coal,	2,567.56	1,123.31
Duty on basis of plunger displacement,	112,030,000	125,380,000
Cost per million gallons raised to reservoir,	\$1.630	\$4.742
Cost per million gallons raised one foot,	0.032	0.036

Consumption.

Estimated total population of the nineteen cities and towns
supplied wholly or partially during the year 1908, 945,360

Total consumption (gallons), pump basis, 46,592,170,000

Average daily consumption (gallons), pump basis, 127,301,000

Gallons per day to each inhabitant, pump basis, 134.7

Distribution.

	Owned and operated by Metropolitan Water and Sewerage Board.	Total in District supplied by Metropolitan Water Works.
Kinds of pipe used,	- 1	- 2
Sizes,	60 to 6 inch.	60 to 4 inch.
Extensions, less length abandoned (miles), . . . . .	.76	20.57
Length in use (miles),	84.65	1,568.85
Stop gates added,	5	-
Stop gates now in use,	372	-
Service pipes added,	-	2,731
Service pipes now in use,	-	152,734 ³
Meters added,	-	7,084
Meters now in use,	-	32,846 ³
Fire hydrants added,	-	252
Fire hydrants now in use,	-	14,079

¹ Cast-iron and cement-lined wrought iron.
² Cast-iron, cement-lined wrought iron and kalamine.
³ 2,709 services and 720 meters destroyed by fire in Chelsea, April 12.

APPENDIX No. 4.

CONTRACTS MADE AND PENDING DURING

Contracts relating to the

	1. Num- ber of Con- tract.	2. WORK.	3. Num- ber of Bids.	AMOUNT OF BID.		6. Contractor.
				4. Next to Low- est.	5. Lowest.	
1	68	Additions to the pumping plant at Deer Island, Boston Harbor.	4	\$69,230 00 ¹	\$51,990 00	Allis-Chalmers Co., Milwaukee, Wis.
2	69	450 tons, Georges Creek Cumberland Coal for Alewife Brook pump- ing station.	5	\$4.60 per ton.	\$4.50 per ton. ¹	Locke Coal Co., Mal- den.
3	70	6,150 tons of coal: — 2,250 tons for Deer Island pumping station. 3,000 tons for East Bos- ton pumping station. 900 tons for Charlestown pumping station.	<div><div>10</div><div>7</div><div>8</div></div>	<div><div>\$4.15 per ton.¹</div><div>\$4.22 per ton.</div><div>\$4.00 per ton.</div></div>	<div><div>\$3.75 per ton.</div><div>\$3.69 per ton.¹</div><div>\$3.95 per ton.¹</div></div>	Davis Coal & Coke Co., Boston.

Contracts relating to the

4	57 ²	Part of Section 82, Exten- sion of the High-level Sewer, Brookline, 78- inch by 84-inch concrete sewer in trench.	9	\$30,415 00	\$30,412 50 ¹	T. J. O'Connell, Bos- ton.
5	60 ²	Part of Section 81, Exten- sion of the High-level Sewer, Brookline, 78- inch by 84-inch concrete sewer in trench.	9	57,450 00	56,980 00 ¹	Bruno & Petitti, Bos- ton.
6	61 ²	Part of Section 81, Exten- sion of the High-level Sewer, Brookline, 78- inch by 84-inch concrete sewer in trench and tun- nel.	5	56,690 00	53,100 00 ¹	Hugh Nawn Contract- ing Co., Boston.
7	62 ²	Part of Section 83, Exten- sion of the High-level Sewer, Brookline, 69- inch by 72-inch concrete sewer in tunnel.	6	59,980 00	54,672 00 ¹	T. J. O'Connell, Bos- ton.

¹ Contract based on this bid.

² Contract completed.

APPENDIX No. 4.

THE YEAR 1908 — SEWERAGE WORKS.

North Metropolitan System.

7. Date of Contract.	8. Date of Completion of Work.	9. Prices of Principal Items of Contracts made in 1908.	10. Value of Work done Decem- ber 31, 1908.	
Nov. 2, 1908,	-	For furnishing and setting up, complete and ready to operate, one pumping engine, actuating vertical shaft and centrifugal pump, with four boilers, pipe connections, economizer and all necessary fittings, the sum of \$69,230.	-	1
July 8, 1908,	June 1, 1909,	\$4.50 per ton of 2,240 lbs., delivered in bins.	\$757 82 ³	2
July 13, 1908,	June 1, 1909,	\$4.15 per ton of 2,240 lbs. delivered in bins at Deer Island pumping station; \$3.69 per ton of 2,240 lbs. delivered in bins at East Boston pumping station; \$3.95 per ton of 2,240 lbs. delivered in bins at Charlestown pumping station.	9,382 55 ³	3

South Metropolitan System.

July 9, 1907,	Jan. 22, 1908,	-	-	\$33,127 64	4
Nov. 23, 1907,	Dec. 14, 1908,	-	-	63,891 52	5
Nov. 25, 1907,	Aug. 25, 1908,	-	-	52,702 82	6
Nov. 26, 1907,	June 8, 1908,	-	-	55,940 19	7

³ Total amount of bills approved by Chief Engineer to Dec. 31, 1908.

CONTRACTS MADE AND PENDING DURING THE
Contracts relating to the South

1. Num- ber of Con- tract.	2. WORK.	3. Num- ber of Bids.	AMOUNT OF BID.		6. Contractor.
			4. Next to Low- est.	5. Lowest.	
1	63 ¹ Part of Section 85, Extension of the High-level Sewer, Brighton, 69-inch by 72-inch concrete sewer in tunnel.	8	\$51,056 00	\$50,856 00 ²	Geo. M. Bryne Company, Boston.
2	64 Part of Section 85, Extension of the High-level Sewer, Brighton, 69-inch by 72-inch concrete sewer in tunnel.	6	94,150 00	92,400 00 ²	D. F. O'Connell Co., Boston.
3	65 ¹ Part of Section 85, Extension of the High-level Sewer, Brighton, 69-inch by 72-inch concrete sewer in tunnel.	3	71,400 00	67,450 00 ²	Hugh Nawn Contracting Co., Boston.
4	66 ¹ 42-inch concrete sewer and 12-inch pipe sewers, along the line of Section 86, Extension of the High-level Sewer, Brighton.	13	9,766 50	8,913 60 ²	Glenn & Broderick, Boston.
5	67 Section 86, Extension of the High-level Sewer, Brighton, 69-inch by 72-inch and 72 inch by 48-inch concrete sewers, in trench.	14	38,716 00	38,054 50 ²	Charles J. Jacobs Co., Boston.
6	71 3,400 tons of coal: — 2,400 tons for Ward Street pumping station. 500 tons for Quincy pumping station. 500 tons for Nut Island screen house.	{ 8 { } 2 { } 7 {	{ \$4.55 per ton. \$4.95 per ton. \$4.20 per ton. ²	{ \$4.41 per ton. ² \$4.45 per ton. ² \$4.15 per ton.	Davis Coal & Coke Co., Boston.

¹ Contract completed. ² Contract based on this bid.

YEAR 1908 — SEWERAGE WORKS — *Continued.**Metropolitan System—Concluded.*

7. Date of Contract.	8. Date of Completion of Work.	9. Prices of Principal Items of Contracts made in 1908.	10. Value of Work done Decem- ber 31, 1908.	
Nov. 27, 1907,	Aug. 20, 1908,	- -	\$50,170 14	1
Nov. 25, 1907,	-	- -	89,930 00	2
Nov. 25, 1907,	Dec. 9, 1908,	- -	68,932 00	3
June 24, 1908,	Dec. 26, 1908,	For earth excavation and refilling in trench for 42-inch concrete sewer, \$4.25 per lin. ft.; for Portland cement brick masonry in manholes, \$14 per cu. yd.; for Portland cement concrete masonry, in trench, \$4.75 per cu. yd.; for earth excavation and refilling, in trench, for 12-inch vitrified pipe sewer; \$1.49 per lin. ft.; for rock excavation, as found, \$4 per cu. yd.	8,911 39	4
Aug. 4, 1908,	-	For earth excavation and refilling, in trench, for 69-inch by 72-inch concrete sewer, \$5.75 per lin. ft.; for earth excavation and refilling, in trench, for 72-inch by 48-inch sewer, \$4.45 per lin. ft.; for Portland cement brick masonry, in trench, \$14 per cu. yd.; for Portland cement concrete masonry, in trench, \$6.70 per cu. yd.; for rock excavation, \$4 per cu. yd.	34,874 76	5
July 13, 1908,	June 1, 1909,	\$4.41 per ton of 2,240 lbs. delivered in bins at Ward Street pumping station. \$4.45 per ton of 2,240 lbs. delivered in bins at Quincy pumping station. \$4.15 per ton of 2,240 lbs. delivered in bins at Nut Island screen house.	5,247 33 ³	6

³ Total amount of bills approved by Chief Engineer to Dec. 31, 1908.

CONTRACTS MADE AND PENDING DURING THE YEAR 1908 — SEWERAGE WORKS
—*Concluded.*

Summary of Contracts.¹

	Value of Work done December 31, 1908.
North Metropolitan System, 1 contract,	
South Metropolitan System, 9 contracts,	\$458,480 46
Total of 10 contracts made and pending during the year 1908,	\$458,480 46

¹ In this summary the cost of day work and contracts charged to maintenance are excluded.

APPENDIX No. 5.

FINANCIAL STATEMENT PRESENTED TO THE GENERAL COURT ON JANU-
ARY 18, 1909.

The Metropolitan Water and Sewerage Board respectfully presents the following abstract of the account of its doings, receipts, expenditures, disbursements, assets and liabilities for the year ending Nov. 30, 1908, in accordance with the provisions of chapter 235 of the Acts of the year 1906.

METROPOLITAN WATER WORKS.

The loans authorized for expenditures under the Metropolitan Water acts, the receipts which are added to the loan fund, the expenditures for the construction and acquisition of works, and the balance available on December 1, 1908, have been as follows:—

Loans authorized under Metropolitan Water acts,	\$40,898,000 00
Receipts from the sales of real estate, and from labor, tools and supplies, which are placed to the credit of the Metropolitan Water Loan Fund:—	
For the year ending November 30, 1908,	\$7,654 53
For the period prior to December 1, 1907,	153,682 00
	<hr/> 161,336 53
	<hr/> \$41,059,336 53
Amount approved for payment by the Board, out of the Metropolitan Water Loan Fund:—	
For the year ending November 30, 1908,	\$206,417 33
For the period prior to December 1, 1907,	40,459,778 07
	<hr/> 40,666,195 40
	<hr/>
Balance December 1, 1908,	\$393,141 13

The amount approved by the board for maintenance and operation of the Metropolitan Water Works during the year ending Nov. 30, 1908, was \$417,493.84.

Sums received from sales of water to municipalities not belonging to the District and to water companies, and from municipalities for admission to the District, have been applied as follows:—

For the period prior to December 1, 1906, distributed to the cities and towns of the District, as provided by section 3 of the Metropolitan Water Act,	\$219,865 65
For the period beginning December 1, 1906, and prior to December 1, 1907, applied to the Metropolitan Water Loan Sinking Fund, as provided by chapter 238 of the Acts of 1907,	7,156 43
For the year beginning December 1, 1907, and ending November 30, 1908, applied to the Metropolitan Water Loan Sinking Fund, as provided by said last-named act,	6,919 61
	<hr/>
	\$233,941 69

The Board has also received the following sums from rentals, land products and other sources, which, according to section 18 of the Metropolitan Water Act, are applied by the Treasurer of the Commonwealth to the payment of interest on the Metropolitan Water Loan, to sinking fund requirements, and expenses of maintenance and operation of works:—

For the year ending November 30, 1908,	\$5,838 78
For the period prior to December 1, 1907,	138,818 19
	<hr/>
	\$144,656 97

METROPOLITAN SEWERAGE WORKS.

The loans authorized under the various acts of the Legislature for the construction of the Metropolitan Sewerage Works, the receipts which are added to the proceeds of the loans, and the expenditures for construction, are given below, as follows:—

NORTH METROPOLITAN SYSTEM.

Loans authorized under the various acts, including those for the Revere, Belmont, Malden extensions and North System enlargement,	\$6,573,869 76
Receipts from sales of real estate and from miscellaneous sources, which are placed to the credit of the North Metropolitan System:—	
For the year ending November 30, 1908,	18,577 77
For the period prior to December 1, 1907,	17,153 40
Amount approved for payment by the Board ¹ out of the Metropolitan Sewerage Loan Fund, North System:—	
For the year ending November 30, 1908,	— 19,392 51
For the period prior to December 1, 1907,	— 6,146,023 16
	<hr/>
	\$6,609,600 93 \$6,165,415 67
Balance, North Metropolitan System, December 1, 1908,	\$444,185 26

¹ The word "Board" refers to the Metropolitan Sewerage Commission and the Metropolitan Water and Sewerage Board.

SOUTH METROPOLITAN SYSTEM.

Charles River Valley Sewer.

Loans authorized under the various acts,	\$800,046 27	
Amount approved by the Metropolitan Sewerage Commission for payment on account of the Charles River valley sewer,	-	\$800,046 27

Neponset Valley Sewer.

Loans authorized under the various acts,	\$904,000 00	
Receipts from pumping, which are placed to the credit of the South Metropolitan System,	109 50	
Amount approved by the Board for payment on account of the Neponset valley sewer: —		
For the year ending November 30, 1908,	-	-
For the period prior to December 1, 1907,	-	911,531 46

High-level Sewer and Extension.

Loans authorized under the various acts,	7,163,000 00	
Receipts from sales of real estate and from miscellaneous sources, which are placed to the credit of the South Metropolitan System: —		
For the year ending November 30, 1908,	3,728 97	
For the period prior to December 1, 1907,	7,243 25	
Amount approved by the Board for payments on account of the High-level Sewer and Extension: —		
For the year ending November 30, 1908,	-	568,012 00
For the period prior to December 1, 1907,	-	6,439,578 02
	<hr/>	<hr/>
	\$8,878,127 99	\$8,719,167 75
Balance, South Metropolitan System, December 1, 1908,		\$158,960 24

For the maintenance and operation of Sewerage Works annual appropriations are made. The balances, appropriations and expenditures for the year ending November 30, 1908, are as follows: —

MAINTENANCE OF NORTH METROPOLITAN SYSTEM.

Appropriated for the year ending November 30, 1908,	\$186,000 00	
Receipts from pumping and from other sources, which are returned to the appropriation: —		
For the year ending November 30, 1908,	567 02	
	<hr/>	\$186,567 02
Amount approved for payment by the Board: —		
For the year ending November 30, 1908,	166,009 10	
	<hr/>	
Balance December 1, 1908,		\$20,557 92

MAINTENANCE OF SOUTH METROPOLITAN SYSTEM.

Appropriated for the year ending November 30, 1908,	\$105,000 00
Receipts from sales of property and for pumping, which are returned to the appropriation: —	
For the year ending November 30, 1908,	129 93
	<hr/>
	\$105,129 93
Amount approved for payment by the Board: —	
For the year ending November 30, 1908,	98,588 80
	<hr/>
Balance December 1, 1908,	\$6,541 13

APPENDIX No. 6.

LEGISLATION OF THE YEAR 1908 AFFECTING THE METROPOLITAN WATER AND SEWERAGE BOARD.

ACTS OF 1908.

[CHAPTER 23.]

AN ACT MAKING AN APPROPRIATION FOR THE COMPENSATION OF CERTAIN VETERANS RETIRED FROM THE SERVICE OF THE COMMONWEALTH.

Be it enacted, etc., as follows:

SECTION 1. A sum not exceeding twenty thousand dollars is hereby appropriated, to be paid out of the treasury of the commonwealth from the ordinary revenue, to provide for the compensation of certain veterans formerly in the service of the commonwealth and now retired from that service under authority of chapter four hundred and fifty-eight of the acts of the year nineteen hundred and seven.

Appropriation to compensate retired veterans.

SECTION 2. This act shall take effect upon its passage.

Approved January 27, 1908.

[CHAPTER 198.]

AN ACT MAKING AN APPROPRIATION FOR THE MAINTENANCE OF THE METROPOLITAN WATER SYSTEM.

Be it enacted, etc., as follows:

SECTION 1. A sum not exceeding four hundred and thirty-three thousand dollars is hereby appropriated, to be paid out of the Metropolitan Water Maintenance Fund, for the maintenance and operation of the metropolitan water system for the cities and towns in what is known as the metropolitan water district, during the fiscal year ending on the thirtieth day of November, nineteen hundred and eight.

Appropriation for maintenance of metropolitan water system.

SECTION 2. This act shall take effect upon its passage.

Approved March 10, 1908.

[CHAPTER 211.]

AN ACT MAKING AN APPROPRIATION FOR OPERATING THE
NORTH METROPOLITAN SYSTEM OF SEWAGE DISPOSAL.*Be it enacted, etc., as follows:*

Appropriation
for mainte-
nance of north
metropolitan
sewerage
system.

SECTION 1. A sum not exceeding one hundred and forty-six thousand dollars is hereby appropriated, to be paid out of the North Metropolitan System Maintenance Fund, for the maintenance and operation of the system of sewage disposal for the cities included in what is known as the north metropolitan system, during the fiscal year ending on the thirtieth day of November, nineteen hundred and eight.

SECTION 2. This act shall take effect upon its passage.

Approved March 14, 1908.

[CHAPTER 213.]

AN ACT MAKING AN APPROPRIATION FOR OPERATING THE
SOUTH METROPOLITAN SYSTEM OF SEWAGE DISPOSAL.*Be it enacted, etc., as follows:*

Appropriation
for mainte-
nance of south
metropolitan
sewerage
system.

SECTION 1. A sum not exceeding one hundred and five thousand dollars is hereby appropriated, to be paid out of the South Metropolitan System Maintenance Fund, for the cost of maintenance and operation of the south metropolitan system of sewage disposal, comprising a part of Boston, the cities of Newton and Waltham, and the towns of Brookline, Watertown, Dedham, Hyde Park and Milton, during the fiscal year ending on the thirtieth day of November, nineteen hundred and eight.

SECTION 2. This act shall take effect upon its passage.

Approved March 14, 1908.

[CHAPTER 456.]

AN ACT TO AUTHORIZE THE TOWN OF ASHLAND TO SUPPLY
ITSELF AND ITS INHABITANTS WITH WATER.*Be it enacted, etc., as follows:*

The town of
Ashland may
supply itself
with water,
etc.

SECTION 1. The town of Ashland may supply itself and its inhabitants with water for the extinguishment of fires and for domestic, manufacturing and other purposes; may establish fountains and hydrants and relocate or discontinue the

same; and may regulate the use of such water and fix and collect rates to be paid therefor.

SECTION 2. Said town, for the purposes aforesaid, may take, or acquire by purchase or otherwise, and hold the waters of any pond or stream or of any ground sources of supply, by means of driven, artesian or other wells within the limits of the town, and the water rights connected with any such water sources, or may purchase water from any individual or corporation; and may avail itself of its existing rights and privileges reserved to it by the provisions of chapter one hundred and seventy-seven of the acts of the year eighteen hundred and seventy-two: *provided, however*, that nothing in this act shall be construed as increasing such rights and privileges, or may make arrangements for obtaining water from the metropolitan water system which shall be satisfactory to the town and to the metropolitan water and sewerage board, and may also take, or acquire by purchase or otherwise, and hold all lands, rights of way and easements necessary for collecting, storing, holding, purifying and preserving the purity of the water and for conveying the same to any part of said town: *provided*, that there is no infringement upon the existing rights and privileges of the metropolitan water system excepting as allowed for above, and *provided*, that no source of water supply and no lands necessary for preserving the quality of such water, shall be taken or used without first obtaining the advice and approval of the state board of health, . . .

Town may arrange to take water from metropolitan water system.

SECTION 10. This act shall take effect upon its acceptance by a majority vote of the legal voters of the town of Ashland present and voting thereon at a legal meeting called for the purpose within three years after its passage; but the number of meetings so called in any one year shall not exceed three; and for the purpose of being submitted to the voters as aforesaid this act shall take effect upon its passage.

Act shall take effect upon acceptance.

Approved April 28, 1908.

[CHAPTER 539.]

AN ACT TO PROVIDE FOR THE BETTER PROTECTION OF THE DOMESTIC WATER SUPPLIES OF THE COMMONWEALTH.

Be it enacted, etc., as follows:

SECTION 1. Any police officer or constable of a city or town in which any pond, stream or reservoir used for the purpose

Police officer or constable or officer of

board, etc., if
duly author-
ized, may
arrest for
bathing.

of domestic water supply is wholly or partly situated, acting within the limits of his city or town, and any executive officer of a water board, board of water commissioners, public institution or water company, furnishing water for domestic purposes, or agent of such water board, board of water commissioners, public institution or water company, duly authorized in writing therefor by such boards, institution or company, acting upon the premises of such board, institution or company and not more than five rods from the water, for such supply may, without a warrant, arrest any person found in the act of bathing in a pond, stream or reservoir, the water of which is used for the purpose aforesaid, and detain him in some convenient place until a complaint can be made against him therefor.

SECTION 2. This act shall take effect upon its passage.

Approved May 26, 1908.

[CHAPTER 556.]

AN ACT TO AUTHORIZE THE METROPOLITAN WATER AND SEWERAGE BOARD TO CONSTRUCT EXTENSIONS AND ADDITIONS AT THE EAST BOSTON AND DEER ISLAND PUMPING STATIONS.

Be it enacted, etc., as follows:

Appropriations for
extension of
East Boston
and Deer
Island pump-
ing stations.

SECTION 1. The sums hereinafter mentioned are appropriated, to be paid out of the treasury of the commonwealth from the Metropolitan Sewerage Loan Fund, North System, for the following purposes: — For the East Boston pumping station, to be expended in the years nineteen hundred and eight, nineteen hundred and nine and nineteen hundred and ten, an amount not exceeding two hundred and fifty thousand dollars; for the Deer Island pumping station, to be expended in the years nineteen hundred and eight, nineteen hundred and nine and nineteen hundred and ten, a sum not exceeding one hundred and ninety-five thousand dollars.

Issue of bonds
authorized.

SECTION 2. For the above purposes the said board may expend any sum heretofore appropriated for the construction of the north metropolitan sewerage system, and to meet the expenses incurred under the provisions of this act and not so provided for the treasurer and receiver general shall, with the approval of the governor and council, issue from time to time, bonds in the name and behalf of the commonwealth and under its seal, to an amount not exceeding four hundred and thirteen

thousand dollars, in addition to the amount of such bonds, heretofore authorized by law. The provisions of chapter four hundred and thirty-nine of the acts of the year eighteen hundred and eighty-nine and of chapter four hundred and twenty-four of the acts of the year eighteen hundred and ninety-eight, and of all acts in amendment thereof and in addition thereto, shall, so far as they may be applicable, apply to the indebtedness authorized by this act. Any premium realized from the sale of said bonds shall be paid into the Metropolitan Sewerage Loans Sinking Fund and placed to the credit of the north metropolitan sewerage system.

SECTION 3. This act shall take effect upon its passage.

Approved May 29, 1908.

[CHAPTER 558.]

AN ACT TO AUTHORIZE THE METROPOLITAN WATER AND SEWERAGE BOARD TO MAKE CERTAIN IMPROVEMENTS IN THE METROPOLITAN WATER WORKS AND TO PROVIDE FOR THE PAYMENT OF CLAIMS.

Be it enacted, etc., as follows:

SECTION 1. The sums hereinafter mentioned are appropriated, to be paid out of the treasury of the commonwealth from the Metropolitan Water Loan Fund, for the following purposes:— For a power plant at the Wachusett dam, a sum not exceeding one hundred and fifteen thousand dollars; for concrete walls and tile floor at the gate and power house at the Wachusett dam, a sum not exceeding seven thousand dollars; for a new forty-eight inch main from Chestnut Hill reservoir to the Boston city line, a sum not exceeding one hundred and ninety thousand dollars; for the completion of the Arlington pumping station and its equipment, a sum not exceeding fourteen thousand five hundred dollars; for the construction of sewers, cesspools and other improvements necessary on the watershed of the Wachusett reservoir, a sum not exceeding five thousand dollars; for settlement of suits now pending in the courts, and for claims and reserves payable upon completed contracts, a sum not exceeding two hundred and sixty thousand dollars.

Appropriations for construction for certain purposes in metropolitan water district and for settlement of claims.

SECTION 2. For the above purposes the said board may expend any sum heretofore appropriated for the construction of metropolitan water works, and to meet the expenses in-

Issue of bonds authorized.

curred under the provisions of this act and not so provided for the treasurer and receiver general shall, from time to time, issue upon the request of said board, bonds in the name and behalf of the commonwealth and under its seal, designated on the face thereof, Metropolitan Water Loan, to an amount not exceeding three hundred and ninety-eight thousand dollars in addition to the sum of forty million five hundred thousand dollars authorized to be issued under the provisions of chapter four hundred and eighty-eight of the acts of the year eighteen hundred and ninety-five, chapter four hundred and fifty-three of the acts of the year nineteen hundred and one and chapter three hundred and sixty-seven of the acts of the year nineteen hundred and six, and the provisions of said chapter four hundred and eighty-eight of the acts of the year eighteen hundred and ninety-five, and of acts in amendment thereof and in addition thereto, shall apply to this additional loan to the same extent as if the amount authorized by said act had been forty million eight hundred and ninety-eight thousand dollars instead of twenty-seven million dollars.

SECTION 3. This act shall take effect upon its passage.

Approved May 29, 1908.

[CHAPTER 560.]

AN ACT TO AUTHORIZE THE ADMISSION OF THE TOWN OF
SWAMPSCOTT TO THE METROPOLITAN WATER DISTRICT.

Be it enacted, etc., as follows:

Town of
Swampscott
may be
included in
metropolitan
water district.

SECTION 1. The metropolitan water and sewerage board may, on application, include the town of Swampscott in the metropolitan water district, and may furnish water to the town on the terms prescribed by chapter four hundred and eighty-eight of the acts of the year eighteen hundred and ninety-five, and by acts in amendment thereof and in addition thereto for the cities and towns included in said district, and on payment of such sum of money as said board may fix.

SECTION 2. This act shall take effect upon its passage.

Approved May 29, 1908.

[CHAPTER 582.]

AN ACT TO AUTHORIZE THE METROPOLITAN WATER AND SEWERAGE BOARD TO RESTORE THE EAST BOSTON SEWERAGE PUMPING STATION AND TO ERECT OTHER BUILDINGS.

Be it enacted, etc., as follows:

SECTION 1. The sum of forty thousand dollars is hereby appropriated, to be paid out of the treasury of the commonwealth from the Metropolitan Sewerage Maintenance Fund, North System, for the restoration of the East Boston sewerage pumping station and its equipment, recently damaged by fire.

Appropriation for restoring East Boston sewerage pumping station.

SECTION 2. The metropolitan water and sewerage board is hereby authorized to use any money received from the sale of land in East Boston to The Standard Oil Company of New York, for the purchase of land and the erection of stable and locker buildings thereon.

Authority to use money received from sale of land.

SECTION 3. This act shall take effect upon its passage.

Approved June 4, 1908.

[CHAPTER 650.]

AN ACT RELATIVE TO THE WEEKLY PAYMENT OF WAGES TO PUBLIC EMPLOYEES.

Be it enacted, etc., as follows:

SECTION 1. Section sixty-two of chapter one hundred and six of the Revised Laws, as amended by chapter four hundred and twenty-seven of the acts of the year nineteen hundred and six, and by chapter one hundred and ninety-three of the acts of the year nineteen hundred and seven, is hereby further amended by inserting after the word "them", in the seventeenth line, the words:— and every person employed by it or them in any penal or charitable institution,— so as to read as follows:— *Section 62.* Every manufacturing, mining, or quarrying, mercantile, railroad, street railway, telegraph or telephone corporation, every incorporated express company or water company, and every contractor, person or partnership engaged in any manufacturing business, in any of the building trades, in quarries or mines, upon public works or in the construction or repair of railroads, street railways, roads, bridges or sewers, or of gas, water or electric light works, pipes or lines, shall pay weekly each employee engaged in his

Act relative to weekly payment of wages to public employees extended.

or its business the wages earned by him to within six days of the date of said payment, but any employee leaving his or her employment, or being discharged from such employment, shall be paid in full on the following regular pay day; and the commonwealth, its officers, boards and commissions shall so pay every mechanic, workman and laborer who is employed by it or them, and every person employed by it or them in any penal or charitable institution, and every county and city shall so pay every employee who is engaged in its business the wages or salary earned by him, unless such mechanic, workman, laborer or employee requests in writing to be paid in a different manner; and every town shall so pay each employee in its business if so required by him; but an employee who is absent from his regular place of labor at a time fixed for payment shall be paid thereafter on demand. The provisions of this section shall not apply to an employee of a co-operative corporation or association if he is a stockholder therein unless he requests such corporation to pay him weekly. The board of railroad commissioners, after a hearing, may exempt any railroad corporation from paying weekly any of its employees if it appears to the board that such employees prefer less frequent payments, and that their interests and the interests of the public will not suffer thereby. No corporation, contractor, person or partnership shall by a special contract with an employee or by any other means exempt himself or itself from the provisions of this and the following section. Whoever violates the provisions of this section shall be punished by a fine of not less than ten nor more than fifty dollars.

SECTION 2. This act shall take effect upon its passage.

Approved June 13, 1908.

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